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Summary of 2011 and 2012 Herring Acoustic Surveys in Northwest Atlantic Fisheries Organization (NAFO) Divisions 4VWX

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Canada

Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the Secretariat.

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TABLE OF CONTENTS

ABSTRACT

Automated acoustic recording systems deployed on commercial fishing vessels have been used since 1997 to document the distribution and relative abundance of Atlantic herring from industry vessel surveys and fishing excursions in the Bay of Fundy and coastal Nova Scotia area within Northwest Atlantic Fisheries Organization divisions 4VWX. In 2011 and 2012, regularly scheduled surveys at approximately 14 day intervals were again conducted on the main spawning components, and the spawning stock biomass for each component estimated by summing these results. In 2011 and 2012, five structured surveys were conducted each year in Scots Bay and three each year on Trinity Ledge. One structured survey was done in 2011 on Spectacle Buoy. In 2011, there were five surveys on German Bank and six in 2012. In most cases, these surveys provided good coverage of the spawning areas consistent with established protocols.

In 2011, the biomass estimate increased by almost 43% above the 2010 estimate for the combined survey areas of Scots Bay, Trinity Ledge and German Bank. The 2012 estimate for the same overall areas increased a further 6% over the 2011 estimate. As a result, the overall estimate is now closer to the long term average. These estimates indicate positive growth in the 4X stock, but most this growth has occurred in the Scots Bay survey area and not on German Bank, which has historically been the major spawning area.

Biomass estimates from surveys of the coastal Nova Scotia spawning components for the Little Hope/Port Mouton, Halifax/Eastern Shore and Glace Bay areas were also examined. Six (2011) and two (2012) surveys were completed for Little Hope, three (2011) and two (2012) surveys for Halifax/Eastern Shore and one (2011) for the Glace Bay area. There were continued decreases in spawning stock biomass recorded for Little Hope and Halifax/Eastern Shore areas, while Glace Bay again showed virtually no fish in the one survey completed in 2011.

Résumé des relevés acoustiques sur le hareng effectués en 2011 et 2012 dans les divisions 4VWX de l'Organisation des pêches de l'Atlantique Nord-Ouest (OPANO)

RÉSUMÉ

Des systèmes d'enregistrement acoustiques automatiques installés sur des bateaux de pêche commerciaux sont employés depuis 1997 pour documenter la répartition et l'abondance relative du hareng dans le cadre de relevés de l'industrie et de sorties de pêche effectués dans la baie de Fundy et la région côtière de la Nouvelle-Écosse à l'intérieur des divisions 4VWX de l'Organisation des pêches de l'Atlantique Nord-Ouest. En 2011 et 2012, on a effectué, à environ 14 jours d'intervalle, des relevés des principales composantes de reproducteurs; on a ensuite évalué la biomasse du stock reproducteur de chaque composante en additionnant les résultats obtenus. En 2011 et en 2012, cinq relevés structurés ont été effectués chaque année dans la baie Scots, tandis que trois relevés ont été effectués chaque année sur le récif de la Trinité. Un relevé structuré a été effectué à partir de la bouée Spectacle en 2011. En 2011, cinq relevés ont été effectués sur le banc German, tandis que six relevés y ont été effectués en 2012. Dans la plupart des cas, ces relevés ont assuré une couverture satisfaisante des frayères, globalement cohérente par rapport aux protocoles établis.

En 2011, l'estimation de la biomasse a augmenté de près de 43 % par rapport à l'estimation de 2010 pour les zones de relevé combinées de la baie Scots, du récif de la Trinité et du banc German. L'estimation de 2012 pour les mêmes zones globales a augmenté de 6 % par rapport à l'estimation de 2011. Par conséquent, l'estimation globale est maintenant plus près de la moyenne à long terme. Ces estimations indiquent une croissance positive dans le stock de la division 4X, mais la majorité de cette croissance a eu lieu dans la zone de relevé de la baie Scots et non sur le banc German, qui était auparavant la principale frayère.

Les estimations de la biomasse à partir des relevés des composantes de reproducteurs des côtes de la Nouvelle-Écosse pour les secteurs de Little Hope/Port Mouton, d'Halifax/côte Est et de Glace Bay ont également été examinées. On a réalisé six (2011) et deux (2012) relevés pour Little Hope, trois (2011) et deux (2012) relevés pour Halifax/côte Est, et un (2011) relevé pour Glace Bay. On a observé des baisses continues dans la biomasse du stock reproducteur dans les secteurs de Little Hope et d'Halifax/côte Est, alors qu'il n'y avait, encore une fois, pratiquement aucun poisson dans le relevé réalisé à Glace Bay en 2011.

INTRODUCTION

Since 1997, the spawning stock biomass (SSB) of Northwest Atlantic Fisheries Organization (NAFO) divisions 4WX herring has been estimated using acoustic surveys conducted by the fishing industry (Stephenson et al. 1998; Power and Melvin 2010). Each year, commercial fishing vessels equipped with calibrated acoustic logging systems undertake both scheduled and unscheduled surveys of herring aggregations on the spawning grounds. The data collected during these surveys serve two purposes. First, when necessary, the data can be analyzed in near real-time, and used as input for the "survey, assess, then fish" protocol, to apportion fishing effort on individual spawning grounds. Secondly, the estimates for individual spawning areas have been summed, under specific assumptions about elapsed time between surveys, to provide an annual index of SSB for assessment processes. The development and implementation of the automatic acoustic systems represents a major improvement in quantifying fish biomass. Pre-1997 estimates relied on the experience of the observer to estimate the amount of fish from mapping surveys, and are considered qualitative only (Melvin et al. 2002).

The use of commercial fishing vessels to survey and estimate SSB was initially developed to provide additional protection of individual spawning components within a global total allowable catch (TAC) during a period (1994/95) of declining biomass. The original qualitative approach, commonly referred to as the "survey, assess, then fish" protocol, continues today, but now uses a quantitative acoustic methodology with a standard survey design (DFO 1997; Melvin and Power 1999; Melvin et al. 2004; Power and Melvin 2010) to provide an index of spawning biomass.

Several major improvements to the approach have been made in survey design and in the standardization of survey coverage to a point where they can be considered comparable from year to year (Melvin and Power 1999; Melvin et al. 2003, 2004; Power and Melvin 2010). The purpose of this document is to report and to summarize the NAFO divisions 4VWX stock assessment related survey data collected during the 2011 and 2012 fishing and survey season.

METHODS

Acoustic and mapping surveys using commercial fishing vessels have been employed to estimate the SSB of individual components within the stock complex since 1999 (Melvin et al. 2004; Power and Melvin 2010; Power et al. 2012).

Data from the 2011 and 2012 fishing seasons were obtained during regularly scheduled structured surveys. Structured surveys included mapping and/or acoustic surveys (Melvin et al. 2001). In 2011 and 2012, only the acoustic surveys were used to determine the biomass estimates.

There were 26 structured surveys and four fishing night surveys completed in 2011 and 18 structured surveys in 2012 (Table 1). The total number of survey boat nights (using acoustic recording systems) completed in 2011 and 2012 were 99 and 104, respectively. In 2011, there was 80 survey nights from 'mapping' vessels without recording systems and 17 in 2012 (Table 2A,B).

Structured surveys were conducted in accordance with the protocol established in Melvin and Power (1999), and there were between 10-20 transects completed to provide good coverage of the defined spawning survey areas. A few exceptions to the normal protocols of survey design did take place and these are explained in more detail where they occur below.

DATA QUALITY ISSUES

As outlined in Power et al. (2012), most of the previous issues with data quality have been resolved. Those issues included the following of surveying protocols, provision and verification of the raw data and editing, and issues of noise and interference. Some of these issues, however, continue to surface including not following survey protocols (i.e. doing a series of loops instead of parallel lines) when documenting fish aggregations on non-survey nights. Data collections inconsistent with established protocols were again given a low priority for analysis or were not incorporated into the SSB estimate.

As detailed in Power et al. (2012), most of the task associated with processing the raw acoustic survey data files have been split between the Herring Science Council (HSC) and Fisheries and Oceans Canada (DFO). A framework assessment meeting was held in January 2007, and it was recommended that all raw data files be made available on a regular basis for review prior to finalizing the acoustic biomass estimates (Power and Melvin 2008). In 2011 and 2012, all raw data files were received and the data compared with the edited results before the final analysis was completed. The main reason for these comparisons is to check for target uncertainty, to distinguish fish from bottom and to examine interference/noise patterns. As a result of these examinations, some data problems were identified and resolved by re-editing the data for some vessels and for specific surveys. In a few cases, the bottom was not completely removed or some non-herring species were apparent.

In 2011 and 2012, vessel noise/interference tests were completed for each vessel as part of the calibration process, and recommended speed or vessel RPM (revolutions per minute) levels were established. As a result of these efforts, the resulting raw data collected was found to have less background noise and was useable from all survey vessels. However, the appearance of sonar noise did occur on a few recordings and this resulted in more editing requirements.

LENGTH/WEIGHT RELATIONSHIP

Prior to 2001, the fish weight variable in the target strength (TS) equation (Table 3A,B) was estimated using a length/weight relationship developed from combined average monthly data for each area. TS was estimated using the generic clupeid equation from Foote (1987). A correction factor of 1.02 was also applied to each length measurement to account for the shrinkage of fish due to freezing, prior to calculating the length/weight relationship (Hunt et al. 1986). This relationship was then used to estimate the weight of a fish for a given length. The time window used to select data appropriate for individual surveys has been narrowed since 2001, to provide a more representative estimate of mean fish weight at the time of surveying. Recent initiatives and continued collaboration with the processing plants have greatly improved sampling, such that it is now possible to obtain a significant number of detailed samples (length/weight data) within a 9-day window (four days prior to or after each of the surveys). These data are used to develop a weight/length relationship specific to each acoustic survey (Table 3A,B). The mean length of herring sampled during the night of the survey (or from landings of the previous night) and the calculated mean weight is then used to estimate TS specific to each survey period. When samples were not available, TS was estimated using values for an 'average spawning fish' at 28cm in length with adjustment for sounder frequency as required.

INTEGRATION CALIBRATION FACTOR

In 2003, an option to account for the non-square waveform observed in a ball calibration was incorporated into the Hydroacoustic Data Processing Software (HDPS) (Melvin et al. 2004). This approach is used by several acoustic manufacturers when calibrating their echo sounders. The effect of including an integration calibration factor (ICF or CIF) to estimate backscatter in the

integration process varies depending on the vessel's acoustic hardware. The multiplier for the factor, which is applied to the standard calibration, typically lies between 0.4 and 1.6, with 1.0 equivalent to an ideal square wave and thus requires no adjustment.

Given that the inclusion of the CIF is deemed to provide a more accurate estimate of biomass, it was recommended that all future analyses utilize the CIF to calculate absolute biomass (Melvin et al. 2004). However, when comparing observations from year to year, it was recommended that the comparisons be made between biomass estimates that exclude the adjustment, until a time series has been established with the CIF included.

Recalculation of SSB estimates for the earlier years from 1999 to 2002 using the CIF has been completed for 2001 and 2002. Analysis for the 1999 and 2000 data is also completed and the results are presented at the 2013 Science Advisory Process (SAP) meeting (Melvin et al. 2014a). The current analysis is the first time all results are presented using calculations with only the CIF. Unless otherwise noted, only biomass estimates with the CIF will be referred to when summarizing the data results.

ACOUSTIC SYSTEMS

As in previous years, acoustic data were collected in 2011 and 2012 using automated logging systems aboard commercial fishing vessels during both standard fishing excursions and structured surveys. The systems, which were activated whenever the captain wished to document observations, automatically saved all data to the system's hard drive. The data were downloaded at regular intervals prior to archiving, data editing and summary analysis.

A total of 20 automated acoustic logging systems (Femto Model DE9320 or Simrad Model ES60) were deployed on commercial fishing vessels in 2011. Systems from Femto Electronics were installed and calibrated aboard nine purse seine vessels, *Brunswick Provider, Canada 100, Sealife II, Island Pride, Lady Janice, Lady Melissa, Lady Noreen, Tasha Marie, Moon Raker,* and *Silver Harvester.* There were also three Simrad ES60 acoustic systems calibrated and used on the purse seine vessels *Margaret Elizabeth, Morning Star* and the *Leroy & Barry.* There were six Femto systems on the inshore herring gillnet vessels *Bradley K, Lady Patricia, Miss Owls Head, Natasha Lee, SKJ, TS,* and the *Wet & Wild.*

As in 2011, a total of 20 of automated acoustic logging systems (Femto Model DE9320 or Simrad Model ES60 or ES70) were deployed on commercial fishing vessels in 2012. The *Moon Raker* and *SKJ* were not available, while the *Atlantic Star* and *Eagle 8* were equipped with Simrad Model ES70 acoustic systems.

STRUCTURED SURVEYS

Structured surveys are defined as those surveys that follow the standard protocol described by Melvin and Power (1999). Under this protocol, commercial vessels follow a series of randomly selected transects within a pre-defined area. The number of transects depends upon the number of vessels involved. Acoustic recording vessels are distributed throughout the survey area to provide representative coverage. The surveys conducted periodically throughout the spawning season are generally scheduled at 2-week intervals. These surveys play an important role in the understanding and perception of the 4WX herring stock. Flexibility is built into the process to allow for schedule changes and for investigation of areas of interest or uncertainty. Structured surveys were conducted on each of the major, and several of the minor, spawning grounds within 4WX, and additional recordings were made of both spawning and non-spawning aggregations during fishing night operations.

FISHING EXCURSIONS

Fishing nights are defined as those occasions when acoustic data are collected by fishing vessels equipped with automated acoustic logging systems during the search phase of a fishing excursion. These data, which often do not follow any formal survey design, provide information on the distribution and abundance of herring during non-survey nights. The data have also been used in the past to document large spawning aggregations not included in a survey and/or as a substitute for a survey, in the event that no other information is available. The approach to the activation of the systems has changed since the start of the program. During the early stages, fishing captains would turn their system on when they reached the fishing ground and off once they deployed their fishing gear. For the last few years, the majority of vessels have activated their systems only when they believed there was something worth recording. This has greatly reduced the amount of time required for archiving, editing, and analyzing.

Analyses of acoustic data from non-survey nights were possible in previous years due to the provision of technical support from the HSC since 2002. Due to reductions in recent years, data from fishing nights were examined only where sufficient aggregations were surveyed and where established survey protocols were followed. Any fishing night estimate found to be higher than the nearest survey estimate for that spawning area and time period can be considered for the overall area estimates. In 2011, fishing nights were examined but none were considered useful in the final analysis for the overall surveys. In 2012, no fishing night data were collected.

RESULTS

The spawning biomass for individual components of the 4WX herring stock complex in 2011 and 2012 was estimated from industry collected data using multiple structured acoustic surveys on major spawning grounds (Figure 1). These surveys, when summed, provide an index of SSB and form the foundation for evaluation of the stock status. The following text provides a summary of the 2011 and 2012 observations and SSB estimates for each of the main spawning components within the stock complex.

BAY OF FUNDY/SOUTHWEST NOVA SCOTIA (SWNS) SPAWNING COMPONENT

Biological Sampling for Maturity

The timing of surveys in relation to the residence time of spawning groups on the spawning grounds continues to be an issue of major concern. The current hypothesis for surveys on individual spawning grounds assumes that there is constant spawning on each ground over the season with individual spawning groups or waves continuously arriving, spawning and then leaving within 10-12 days (or less).

Sampling data for maturity supports the view of continuous spawning or waves with high proportions of ripe and running (Stage 6) fish observed over an extended period. The 10-14 day window between surveys also assumes that there will be no double counting and that the maturing (hard/Stage 5), as well as the spawning (Stage 6) fish in the samples will also have spawned and left before the next survey.

The samples from the standard biological sampling program conducted by staff at the St. Andrews Biological Station (SABS) provide data on individual fish for length, weight, sex, maturity stage, gonad weight, and age. These samples are collected from various sources including research surveys, tagging trips and acoustic surveys, and from landings at various plants. For comparison with the industry categorization, a modification to the SABS lab procedure to weigh all gonad stages was implemented in 2003. SABS samples were combined for female fish by day and percent numbers and percent weight by the categories determined. The plant classification system of maturity must not be confused with the standardized ICES

(International Council for the Exploration of the Sea) scientific scale of 1 to 8 (Parrish and Saville 1965), but the industry roe data can be compared with SABS data based on knowledge of the two methods. Analysis of the roe maturities was completed for the data available on an individual survey basis and is presented with the details for each survey area.

Spawning Ground Turnover Rates

The current acoustic survey method on spawning grounds is dependent on the assumption of periodic turnover of spawning fish. Acoustic surveys are required to be separated by at least 10-14 days to allow for turnover and to prevent double counting (Power et al. 2002). This aspect of the assessment method was the subject of investigation in 2001 and of intensive sampling for maturity stage since that fishing season. The results and application to the acoustic surveys are summarized by Melvin et al. (2002, 2003, 2004), Power et al. (2005, 2006, 2007, 2008) and by Power and Melvin (2010) and were used to assist in the evaluation of turnover timing and the inclusion or exclusion of specific acoustic surveys.

From 1998 to 2002, the Pelagics Research Council/HSC, in partnership with DFO, tagged herring on spawning grounds and on the major Nova Scotia over-wintering grounds. The information on tags returned from this study has been summarized by Waters and Clark (2005). Evidence from tagging experiments conducted in 1998 of ripe and running (spawning) herring showed that the residence time for most returns on the same grounds was less than 7-10 days; however, 25% of returns were captured on the same grounds after more than 10 days at large (Paul 1999). In contrast, a similar experiment in September 2001 on German Bank showed no recaptures after nine days on the same grounds during the same spawning season (Power et al. 2002). This latter result was complicated by a large decrease in fishing effort (and thus returns) during the second week after tagging.

In response to a recommendation from the 2005 regional advisory process review, tags were applied to herring on the spawning grounds of Scots Bay and German Bank (Clark 2007). The results from the tag returns indicated that some tagged herring remained on the spawning grounds for at least three weeks after tagging and, in some cases, up to 5-6 weeks after tagging. Thus, acoustic surveys that were spaced at 2-week intervals were surveying some of the same fish twice or possibly even three times.

These results may have serious implications in how the acoustic surveys are evaluated and used to determine stock status. Some preliminary analysis has been completed comparing three different approaches for the interpretation of the acoustic biomass estimates in an absolute sense (Power et al. 2006). The results showed that caution is warranted when employing the cumulative biomass estimates as absolute in any of the survey areas. The results also indicated that some proportion of herring remain in the survey area even three weeks or longer. However, these adjustments do not change the overall trends over time, but rather apply a scaling to the absolute amounts.

The framework assessment meeting in January 2007 determined that double counting does occur, but the extent has not been well determined (DFO 2007). However, it was still recommended to continue to do surveys at 10-14 day intervals to avoid double sampling. The timing/turnover issue was considered to be of highest importance for further study, which should include work on the duration of the maturation process, further tagging with more frequent intervals to estimate turnover rates and increased survey frequency to reflect maturity stage duration.

Melvin et al. (2014b) updated the tagging study on German Bank during the spawning period that was completed in 2011.

Acoustic Surveys

Scots Bay

The Scots Bay herring purse seine fishery has been an important component of the summer fishery with catches since 1987, ranging from 1,000t to 24,400t during the period of early July to late August-early September (Power et al. 2010). In both 2011 and 2012, the Scots Bay fishery was again restricted with a 5,000t cap due to the poor performance of the spawning component since 2005. Landings in 2009 were substantially reduced from 2008, with only 900t caught from July 12 to August 11 (Power et al. 2010).

In 2011, landings in Scots Bay increased to 5,093t, with landing dates from July 4 to September 1. Those numbers decreased in 2012 to 4.940t, with landing dates from July 2 to August 28. Most of the catches in 2011 and 2012 were located within the defined survey box area, but there were substantial catches located outside the box either in Advocate Bay or into the upper part of Scots Bay.

Sampling was adequate with samples from most landings allowing detailed description of the size and maturity of fish captured (figures 2A,B, and 3A,B). Samples for gonad maturity showed mostly ripe and running (spawning), as well some maturing (Stage 5) stages (Figure 3A,B). Some immature juvenile fish were also picked up from research bottom trawl samples collected in the area from July 12-17 in 2011 and July 13-16 in 2012.

2011 Scots Bay Acoustic Surveys

Six structured surveys were conducted during the 2011 spawning season in Scots Bay, which is same as in 2010 (Table 2A). The surveys were separated by a minimum of 13 days and provided good coverage of the survey area.

Scots Bay Acoustic Survey #1: July 2, 2011

- This survey was conducted by six boats all with acoustic systems. Figure 4A shows the tracks of the vessels. There was good coverage of the survey box and some transects in the north and east of the box. Some boats failed to turn off their other acoustic equipment and as a result there was some loss of data due to interference from sonar.
- In the "hook" (east of the box) area boats failed to keep straight lines and/or complete their lines.
- Sampling data using 12 fishery samples from (2-3 days after the survey) had a mean size of 25.8cm, with 8.7% being less than (<)23cm and average weight of 137g. These samples were used in TS calculation with adjustment for frequency of the echo sounder (Figure 5A).
- Maturity sampling by the fishery showed 81% of the fish in ripe and running condition (Stage 6) (Figure 3A).
- The initial analysis of 40,341t by A. Clay of Femto Electronics for the survey area coverage of 923km^2 using standard TS (with CIF) was revised to 37,705t, with an average sample TS of -35.13. (Table 4A).
- Analysis by depth layer for the transects within the survey box area showed 43% of the total biomass in the 0-10m depth zone and 74% <40m off bottom (Figure 6A).

Scots Bay Acoustic Survey #2: July 16, 2011

- This survey was conducted by six boats, all with acoustic systems. Each boat completed two transects within the defined survey box area and some transects in the north and east of the box for a total coverage of 938km^2 (Figure 7A). There was some loss of data due to interference from other operating acoustic equipment.

- Sampling data using eight fishery samples from (1-2 days after the survey) had a mean size of 25.5cm and average weight of 130g. These samples were used in TS calculation, with adjustment for frequency of the echo sounder (Figure 8A).
- Maturity sampling by the fishery showed fish mainly in maturing/hard spawning condition (stages 4-5) with a range from 36-100% over the period of July 12-19th. Research samples (2) were collected at the same time, but mainly from outside of the survey box area. A mixture of juvenile and adult stage fish (Figure 3A) were observed.
- Initial analysis was completed by A. Clay, with an estimate of 40,191t for the entire survey area using standard TS (with CIF). Analysis with revised sample TS of -35.12 resulted in a total biomass of 38,600t.
- Analysis by depth layer for transects within the survey box area showed 41.1% of the survey biomass was found in the 0-5m depth zone off bottom (Figure 9A).

Scots Bay Acoustic Survey #3: July 30, 2011

- This survey was conducted by seven boats, all with acoustic recording systems. Each boat completed two transects within the defined survey box area and some transects in the north and east of the box for a total coverage of 910km^2 (Figure 10A).
- There was some loss of data due to interference from other operating acoustic equipment. Additionally, one vessel, the *Sealife*, did not have GPS data recorded as a result this information was inserted into the acoustic data using the assigned track plan and the times synchronized with the adjacent vessel, the *Lady Patricia*. The interpretation of the acoustic backscatter found no large aggregations along the lines (Figure 10A).
- Sampling data using fishery samples from August 1-2 (1-2 days after the survey) had a mean size of 25.4cm and average weight of 134g (Figure 11A). These samples were used in TS calculation with adjustment for frequency of the echo sounder.
- Initial analysis was completed by A. Clay, with an estimate of 39,870t for the entire survey area using standard TS (with CIF). Analysis with revised sample TS resulted in a biomass of 34,576t.
- Analysis by depth layer for the transects within the survey box area showed the biomass distribution was more evenly distributed in the water column, with only 14.3% in the bottom 5m compared with 41.1% seen in the previous survey (Figure 12A).

Scots Bay Acoustic Survey #4: August 13, 2011

- This survey was conducted by six boats, all with acoustic recording systems. Each boat completed two within the defined survey box area and some transects in the north and east of the box for a total coverage of 921km^2 (Figure 13A).
- Boats followed assigned lines; however, there were problems with interference from other acoustic equipment in two boats. Two other boats turned on and off their sonars for short periods but the data were recovered. One boat, the *Tasha Marie*, seemed to lose power intermittently causing the system to restart. The interpretation of the acoustic backscatter showed only a few significant aggregations along the line (Figure 13A).
- Sampling data using fishery samples from August 15 (two days after the survey) had a mean size of 25.1cm and average weight of 128g (Figure 14A). These samples were used in TS calculation with adjustment for frequency of the echo sounder.
- Initial analysis was completed by A. Clay, with an estimate of 16,989t for the entire survey area, using standard TS (with CIF). Analysis with revised sample TS resulted in a biomass of 16,898t, with the inbox area giving a biomass estimate of 14,928t (with CIF) and outbox area of 1,970t biomass.
- Analysis by depth layer for transects within the survey box area showed 75% in the first 15m off bottom (Figure 15A).

Scots Bay Acoustic Survey #5: August 26, 2011

- This survey was conducted by six boats with acoustic recording systems. Each boat completed two transects within the defined survey box area and in the north and east of the box for a total coverage of 925km^2 (Figure 16A).
- This survey was compromised by the failure of three boats to turn off their other acoustic equipment causing the loss of some data. The *Canada 100* turned on its sonar for short periods but the data was recovered.
- The interpretation of the acoustic backscatter showed only a few significant aggregations along the lines with most targets thinly and uniformly distributed.
- Sampling data using nine fishery samples from August 27-28 (1-2 days after the survey) had a mean size of 24.8cm and average weight of 122g (Figure 17A). These samples were used in TS calculation with adjustment for frequency of the echo sounder.
- Maturity samples confirmed that fish caught in the area had mature roe in spawning condition with a mixture of hard (Stage 5) and ripe/running (Stage 6).
- Initial analysis was completed by A. Clay, with an estimate of 16,358t for the entire survey area using standard TS (with CIF). Analysis with revised sample TS resulted in a total biomass of 12,933t within the area surveyed. The inbox area coverage of 626km^2 gave a biomass of 7,135t and the outbox area of 299km^2 a biomass estimate of 5,798t (with CIF).
- Analysis by depth layer for the transects within the survey box area showed only 22.7% in the first 20m off bottom, which is more dispersed than seen in previous surveys (Figure 18A).

Scots Bay Acoustic Survey #6: September 25, 2011

- This survey was conducted by one boat, the *Lady Patricia*, with an acoustic recording system. This was a broad scale scouting mission and did not follow survey protocol.
- As a result, this survey was excluded from the biomass estimate for the area.

2011 Scots Bay Acoustic Surveys Summary

All five of the structured surveys used in the biomass estimate were conducted between July 2 and August 26, 2011. In all instances, there was sufficient biological sampling from catches to calculate the TS for use in estimating the total biomass. The August 26, 2011, survey (#5) showed a skewed depth layer distribution of fish with most of the biomass occurring above 20m from the bottom. The fishery samples do, however, indicate that most of the fish were spawning fish.

The 2011 Scots Bay acoustic survey SSB estimate from the five structured surveys within the survey box area (inbox) was 105,613t (with CIF). The total biomass estimate for areas surveyed outside of the standard survey box in the Scots Bay area was 35,099t from surveys. The final 2011 Scots Bay acoustic survey estimate for all areas was 140,712t with CIF (Table 4A).

2012 Scots Bay Acoustic Surveys

As in 2011, five structured surveys were conducted during the 2012 spawning season in Scots Bay (Table 2B). The surveys were separated by a minimum of 13 days and provided good coverage of the survey area.

Scots Bay Acoustic Survey #1: June 30, 2012

- This survey was conducted by 11 boats with acoustic recording systems. Each boat completed two transects within the defined survey box area with additional coverage in the north and east of the box for a total coverage of 840km^2 (Figure 4B).

- This survey was compromised by the failure of one boat to turn off its sonar equipment causing the loss of some data. The *Canada 100* turned on its sonar for short periods but followed the survey protocol.
- The interpretation of the acoustic backscatter showed several significant aggregations along the lines with most targets thinly and uniformly distributed.
- Sampling data using fishery samples from July 2 (two days after the survey) had a mean size of 27.0cm and average weight of 163g (Figure 5B). These samples were used in TS calculation with adjustment for frequency of the echo sounder.
- Maturity samples confirmed that fish caught in the area had mature roe in spawning condition with more "hard" (Stage 5, 76%) than "ripe/running" (Stage 6, 24%) (Figure 3B). This being the first survey in 2012, these fish may or may not have spawned and left the area by the time of the next survey on July 14, 2012.
- Initial analysis was completed by A. Clay with an estimate of 60,719t for the entire survey area using standard TS (with CIF). Analysis with revised sample TS resulted in a total biomass of 59,795t within the area surveyed. The inbox area coverage of 626km^2 gave a biomass of 39,748t and the outbox area of 214km^2 a biomass estimate of 20,047t (with CIF).
- Analysis by depth layer for transects within the survey box area showed 45.3% in the first 20m off bottom (Figure 6B). A larger percent of fish are above 20m from the bottom, but, as stated before, they could have spawned by the time of the next survey on July 14, 2012.

Scots Bay Acoustic Survey #2: July 14, 2012

- This survey was conducted by 11 boats with acoustic recording systems. Each boat completed two transects within the defined survey box area and some coverage in the north and east of the box for a total coverage of 824km^2 (Figure 7B).
- In general, there was minor interference from other acoustic equipment resulting in data recordings with minor data loss.
- The interpretation of the acoustic backscatter showed a few significant aggregations along the lines with most targets thinly and uniformly distributed.
- Sampling data using fishery samples from July 16 (two days after the survey) had a mean size of 27.0cm and average weight of 157g (Figure 8B). These samples were used in TS calculation with adjustment for frequency of the echo sounder.
- Maturity sampling by the fishery showed fish in maturing/hard spawning condition (stages 4-6). The July 16 fishery sample had 71% in the ripe and running stage. Research samples were collected at the same time but mainly from outside of the survey box area. A mixture of juvenile and adult stage fish (Figure 3B) were observed.
- Initial analysis was completed by A. Clay, with an estimate of 60,325t for the entire survey area using standard TS (with CIF). Analysis with revised sample TS resulted in a total biomass of 55,788t within the area surveyed. The inbox area coverage of 626km^2 gave a biomass of 55,788t and the outbox area of 192km^2 a biomass estimate of 14,339t (with CIF).
- Analysis by depth layer for the transects within the survey box area showed 72.5% in the first 20m off bottom (Figure 9B) as opposed to the first survey where only 45.3% were in the first 20m off the bottom.

Scots Bay Acoustic Survey #3: July 28, 2012

- This survey was conducted by 10 boats with acoustic recording systems. Nine boats completed two transects within the defined survey box area. One boat conducted transects to the north, while the *Silver Harvester*, which experienced acoustic system failure, conducted a mapping survey to the east of the box. The total acoustic system coverage was 750km^2 (Figure 10B).
- This survey was compromised by the failure of some boats to keep their other acoustic equipment off. The *Lady Noreen* lost power on her first transect and had to abandon the

survey, while the *Lady Melissa* had to abandon her transect to help the *Lady Noreen*. Another vessel tried to complete the *Lady Noreen*'s transect but failed to start at the correct position. As a result, that portion of the transect was excluded from the analysis.

- The interpretation of the acoustic backscatter showed some significant aggregations along some of the lines.
- Sampling data using fishery samples from July 29-30 (1-2 days after the survey) had a mean size of 26.7cm and average weight of 153g (Figure 11B). These samples were used in TS calculation with adjustment for frequency of the echo sounder.
- Maturity samples confirmed that fish caught in the area had mature roe in spawning condition with a mixture of maturing/hard (Stage 4-5) and ripe and running (Stage 6) (Figure 3B).
- Initial analysis was completed by A. Clay, with an estimate of 39,306t for the entire survey area using standard TS (with CIF). Analysis with revised sample TS resulted in a total biomass of 38,756t within the area surveyed. The inbox area coverage of 626km^2 gave a biomass of 32,626t and the outbox area of 117km^2 a biomass estimate of 6,120t (with CIF).
- Analysis by depth layer for the transects within the survey box area showed 81.4% in the first 20m off bottom (Figure 12B).

Scots Bay Acoustic Survey #4: August 11, 2012

- This survey was conducted by eight boats with acoustic recording systems. Each boat completed two transects within the defined survey box area of 703km^2 (Figure 13B).
- Some boats did no turn off their other acoustic equipment when fish were present resulting in loss of some data.
- The interpretation of the acoustic backscatter showed a few significant aggregations along the lines with most targets thinly and uniformly distributed.
- Sampling data using fishery samples from August 13 (two days after the survey) had a mean size of 26.4cm and average weight of 146g (Figure 14B). These samples were used in TS calculation with adjustment for frequency of the echo sounder.
- Maturity samples confirmed that fish caught in the area had mature roe in spawning condition with a mixture of mostly hard (Stage 5, 58%) and ripe/running (Stage 6, 29%) (Figure 3B).
- Initial analysis was completed by A. Clay, with an estimate of 20,519t for the entire survey area using standard TS (with CIF). Analysis with revised sample TS resulted in a total biomass of 20,940t within the area surveyed. The inbox area coverage of 626km^2 gave a biomass of 20,369t and the outbox area of 77km^2 a biomass estimate of 570t (with CIF).
- Analysis by depth layer for the transects within the survey box area showed 88.3% in the first 20m off bottom (Figure 15B).

Scots Bay Acoustic Survey #5: August 25, 2012

- This survey was conducted by seven boats with acoustic recording systems. Each boat completed two transects within the defined survey box area for a total coverage of 670km^2 (Figure 16B).
- The interpretation of the acoustic backscatter showed a few significant aggregations along the lines with most targets thinly and uniformly distributed.
- Sampling data using fishery samples from August 26-27 (1-2 days after the survey) had a mean size of 26.2cm and average weight of 144g (Figure 17B). These samples were used in TS calculation with adjustment for frequency of the echo sounder.
- Maturity samples confirmed that fish caught in the area had mature roe in spawning condition with a mixture of mostly hard (Stage 5) and ripe/running (Stage 6) (Figure 3B).
- Initial analysis was completed by A. Clay, with an estimate of 10,609t for the entire survey area using standard TS (with CIF). Analysis with revised sample TS resulted in a total

biomass of 9,550t within the area surveyed. The inbox area coverage of 626km^2 gave a biomass of 9,348t and the outbox area of 44km^2 a biomass estimate of 202t (with CIF).

- Analysis by depth layer for the transects within the survey box area showed 79.9% of the biomass were in the first 20m off bottom (Figure 18B).

2012 Scots Bay Acoustic Surveys Summary

All five of the structured surveys used in the biomass estimate were conducted between June 30 and August 25, 2012. In all instances, there was sufficient biological sampling from catches to calculate the TS for use in estimating the total biomass. In the first survey (#1) completed in 2012 (June 30), the maturity of the fish in the sample was 76% Stage 5, in contrast to the first (July 2) survey of 2011, which had 81% Stage 6.

The 2012 Scots Bay acoustic survey total SSB estimate from the five structured surveys within the survey box area (inbox) was 143,550t (with CIF). The total biomass estimate for areas surveyed outside of the standard survey box in the Scots Bay area was 41,279t from surveys. The final 2012 Scots Bay acoustic survey estimate for all areas was 184,828t with CIF (Table 4B).

German Bank

The German Bank herring purse seine fishery has been a major component of the summer fishery with catches since 1985, ranging from 9,000t to 36,000t during the overall fishery period of early May to late October (Power et al. 2010). In 2009, catches of spawning herring were more widespread with localized groups seen in both the northern and southern portions of the standard survey area on German Bank (Power et al. 2010). In 2010, catches were similar in distribution to those of 2009, with 17,491t reported from within the survey box area over the entire year. As in the recent years, catches of spawning herring were more widespread with localized groups seen in both the northern and southern portions of the standard survey area on German Bank in 2011 (17,596t within the survey area) and again in 2012 (27,609t within the survey box).

Five acoustic surveys were conducted on German Bank during the 2011 season between August 26 and October 23 covering the entire spawning period (Table 2A). The time interval between surveys ranged from 12-19 days, and a total of 35 vessel nights of surveying were completed for the German Bank area (Table 2A). In addition to the acoustic recordings, visual observations from the sounder were recorded at 5-10 minute intervals on deck sheets for all vessels.

In 2012, six acoustic surveys were conducted on German Bank between August 12 and October 24 covering the entire spawning period (Table 2B). The time interval between surveys ranged from 13-17 days, and a total of 44 vessel nights of surveying were completed for the German Bank area (Table 2B). As in 2011, in addition to the acoustic recordings, visual observations from the sounder were recorded at 5-10 minute intervals on deck sheets for all vessels.

In both 2011 and 2012, fish samples for maturity indicated that mature spawning herring (stages 5-6) dominated samples collected. Immature juvenile herring were collected in the spawning box area by the Canadian Coast Guard Ship (CCGS) *Alfred Needler* between August 24 and September 1 in 2011 (Figure 19A,B). In 2011, immature fish were also present in the maturity samples on October 3, 4 and 12 (Figure 19A). There was a corresponding decrease in the mean length for those dates (Figure 20A). As in previous years, length sampling was very extensive for this fishery with fish sampled from within the survey box found to be mostly larger than 23cm, which is the approximate size of 50% maturity for first spawning in this stock (Figure 20A,B). There was a corresponding decrease in the mean length in 2011 when immature fish were present (Figure 20A). Overall, pre-spawning herring of <23cm were

infrequent in 2011 and 2012 but were occasionally high (for example in mid-August 2012), indicating there was a mixture of juvenile and adult fish available on the grounds on some occasions.

2011 German Bank Acoustic Surveys

German Bank Acoustic Survey #1: August 26, 2011

- Six acoustic survey vessels including the *Alfred Needler* participated in this survey with eight transects within the survey box and two outside (Figure 21A).
- There were indications of small immature fish in the south and larger spawners in the north from both fishery and *Alfred Needler* trawl/midwater sampling (Figure 22A). Sample locations showed only 1 sample in northern area and 10 in the south (Figure 21A). As a result the transect lines were divided into north and south at the 43°24′ latitude position.
- The one sample (202 fish) from the northern section showed a mean length of 26.5cm and a weight of 141g with none <23cm (Figure 22A). The catch weight of 10 southern samples (1864 fish) showed a mean of 22.1cm length, a weight of 85g and with 69% <23cm (Figure 22A).
- The northern sample was used to estimate TS for the northern part of the survey box, while the southern samples were used for TS with the southern portion and biomass was calculated for the two areas.
- For the final spawning biomass estimate, the proportion of fish <23cm were removed from the biomass for the southern group to provide the SSB for the spawners only. This reduced the estimate in the southern group by 8,611t and gave an overall estimate of 30,404t, a substantial reduction of 60% of the initial estimate by A. Clay of 50,658t. The reduction was due to the smaller mean size and the presence of large numbers of juveniles, which were documented by both the fishery and research survey.
- Final estimate of 27,414t using a standard area of 646km^2 for inbox and 2,991 for the estimated outbox area of 224km^2.
- Analysis by depth layer for transects within the survey box area showed 95.8% of the total area backscattering strength (Sa) was found within the first 10m off bottom, with 39.4% in the zone 1-2m off bottom (Figure 23A).

German Bank Acoustic Survey #2: September 8, 2011

- This survey was conducted by eight acoustic vessels with one vessel failing to maintain a straight line. There was excellent coverage of the survey box. There were 18 transects completed with two main areas of fish documented and sampled (Figure 24A).
- There were nine fishery samples available for September 7-8 including one with small fish. The mean size was 26.6cm, with 7% <23cm for the catch weighted sampled numbers; however, no adjustment was made to remove juveniles from the estimate (Figure 25A).
- Initial analysis was completed by A. Clay, with an estimate of 140,006t for the entire survey area using standard TS (with CIF). Analysis with revised sample TS resulted in a total biomass of 116,508t within the area surveyed. The inbox area coverage of 646km^2 gave a biomass of 111,164t and the outbox area of 204km^2 a biomass estimate of 5,344t (with CIF).
- Layer analysis showed 85.4% of the biomass came from the bottom 5m and 25.9% of the total biomass was within the layer 1-2m off bottom (Figure 26A).

German Bank Acoustic Survey #3: September 21, 2011

- This survey was conducted by 10 acoustic survey vessels with a total of 17 useable transect in the survey box area and another six near the Seal Island area (Figure 27A). One vessel failed to log data for most of one transect and equipment problems.

- Sampling data using fishery samples collected on September 21 with a mean size of 26.2cm and average weight of 139g was used for TS calculation with adjustment for frequency of the echo sounder (Figure 28A).
- Initial analysis by A. Clay gave an estimate of 159,186t, using standard TS for a 28cm fish, for the survey box area and 2353t for the Seal Island area. When the sample TS was applied, the result was 139,682t for the survey area and 1472t for the Seal Island area.
- Final total estimate excluding the Seal Island estimate was 143,937t with separation for inbox (142,509t) and outbox (1,428t) areas (calculated with CIF).
- Analysis by depth layer for transects within the survey box area showed 38.2% of the total biomass was found within the zone 0-5m off bottom, with 12.4% in the 1-2m depth zone (Figure 29A).

German Bank Acoustic Survey #4: October 10, 2011

- This survey was conducted by six boats with acoustic systems with a total of 12 transects in the area with three outer transects being outside the survey box (Figure 30A).
- Transects done by the *Lady Noreen* detected small dense balls near the bottom. Some of these were removed in the initial editing and the final editing where there were doubts as whether they were herring.
- Sampling data using 24 fishery samples collected on October 10-11, with a mean size of 25.8cm and average weight of 124g, was used in TS calculation with adjustment for frequency of the echo sounder (Figure 31A). Herring <23cm made up 12.3% of the samples and the final biomass estimate was adjusted accordingly.
- Initial analysis showed estimates of 13,337t by A. Clay for the overall area (standard TS for 28cm) with no adjustment for juveniles. When fishery sample TS was included the result was 10,542t without the adjustment for juveniles.
- Final total biomass estimate was adjusted for 951t of juveniles resulting in 9,611t (calculated with CIF). Within the box there were 7,889t, while another 1,722t occurred outside the defined survey box.
- Analysis by depth layer for transects within the survey box area showed 27.8% of the total biomass was found within the zone 0-5m off bottom with 10% in the 1-2m depth zone alone (Figure 32A).

German Bank Acoustic Survey #5: October 23, 2011

- This survey was conducted by five boats, all with acoustic systems. Two of the boats completed only one transect each, while the others completed two each. The coverage of the survey box was limited with only about 40% of the area surveyed. One boat appeared to have hardware problems and failed to record completed lines (Figure 33A).
- There was no sampling data collected for this survey and combined with the initial low biomass estimate and the poor survey coverage of the survey box, this survey was excluded from the final biomass estimates for German Bank (see Table 5A).

2011 German Bank Acoustic Surveys Summary

The overall 2010 German Bank biomass was estimated to be 253,768t using seven of eight structured surveys covering a period extending from August 18 to October 16. In 2011, four structured surveys conducted between August 26 and October 10 were used to determine a spawning biomass estimate of 288,976t within the survey box and 11,485t outside the box. This resulted in an overall survey biomass of 300,461t. The October 10th survey (#4) was adjusted for the presence of juveniles.

2012 German Bank Acoustic Surveys

There were six surveys on German Bank between August 12 and October 24.

German Bank Acoustic Survey #1: August 12, 2012

- This survey was conducted by six acoustic survey vessels with a total of 12 transects in the area with one vessel failing to maintain a straight line (Figure 21B). The backscatter data indicate fish were aggregated in the centre of the box, as well as in the north.
- Fishing occurred only on the aggregation in the middle part of the box and on the edges of the northern aggregation. The samples from the edges of the northern aggregation indicated high percentages of small fish. For this analysis, however, only the samples from the central aggregation were used for generating the TS because of the uncertainty about the composition of the central northern aggregation.
- Sampling data using 11 fishery samples collected on August 11-14 with a mean size of 27.0cm and average weight of 152g were used for final TS calculation with an adjustment for frequency of the echo sounder (Figure 22B).
- Initial analysis by A. Clay, with overall 40,012t (standard TS for 28cm, with CIF). Final estimate of 33,541t (calculated with CIF) for the total area combined using a standard area of 646km^2 for inbox and estimated outbox area as 181km^2.
- Analysis by depth layer for transects within the survey box area showed 68.4% of the total area backscattering strength (Sa) was found within the first 10m off bottom with12.9% in the zone 1-2m off bottom alone (Figure 23B).

German Bank Acoustic Survey #2: August 26, 2012

- This survey was conducted by seven survey vessels for a total of 14 acoustic transects (Figure 24B). Two transects were east of the main survey box area and one to the west of the box.
- Sampling data from fishery on August 27-28 had a mean size of 26.7cm and average weight of 144g, which was used for final TS calculation with adjustments for frequency (Figure 25B).
- Initial analysis by A. Clay of 125,446t (with CIF) using standard TS based on mean 28cm/ 180g fish. The final estimate of 107,995t (calculated with CIF) for the total area combined using fishery samples for TS with 102,448t within the box and 5,506t outside the box.
- Layer analysis showed 24.2% of the biomass came from the bottom 5m and 5.8% of the total biomass was within the layer 1-2m off bottom (Figure 26B).

German Bank Acoustic Survey #3: September 9, 2012

- This survey was conducted by 12 acoustic survey vessels with a total of 24 transects (Figure 27B). There was a lot of surface "reverberation", which was not edited out of the data. These were considered to have negligible contribution to the overall biomass estimate.
- The *Silver Harvester* did not turn on the GPS so the navigation had to be repopulated from the deck sheets. The *Canada 100* left some acoustic gear on that caused significant interference. The first transect line of data from the *Island Pride* was unusable because of noise, which cleared up at the beginning of the second line. The survey was hampered by poor weather.
- Sampling data using 20 fishery samples collected on September 7, with a mean size of 26.5cm and average weight of 145g was used for TS calculation with adjustment for frequency of the echo sounder (Figure 28B).
- Initial analysis of 67,804t by A. Clay used standard TS for a 28cm fish for a single combined area. The final total estimate of 59,917t with separation for inbox of 58,699t and outbox 1,217t (calculated with CIF).

- Analysis by depth layer for transects within the survey box area showed 26.2% of the total biomass was found within the zone 0-5m off bottom, with 5.9% in the 1-2m depth zone (Figure 29B).

German Bank Acoustic Survey #4: September 22, 2012

- Eight vessels participated in this survey resulting in 16 transects with the two outer ones being considered as being out of the survey box. The survey was hampered by poor weather, and there was a significant amount of surface "reverberation" which was not edited out (Figure 30B).
- Sampling data using 15 catch weighted fishery samples collected on September 21, with a mean size of 26.1cm and average weight of 141g, was used in TS calculation with adjustment for frequency of the echo sounder (Figure 31B).
- Initial analysis of 66,323t by A. Clay for the overall area (standard TS for 28cm, with CIF). The final total biomass estimate of 59,213t (calculated with CIF) for the overall area, with 58,933t within the survey box and 280t outside the box.
- Analysis by depth layer for transects within the survey box area showed 36.2% of the total biomass was found within the zone 0-5m off bottom, with 7.7% in the 1-2m depth zone alone (Figure 32B).

German Bank Acoustic Survey #5: October 7, 2012

- This survey was conducted by 10 boats, all with acoustic systems. Each boat completed two transects within the area for a coverage of 812km^2 (Figure 33B). There was a significant amount of surface "reverberation" which was edited out. A very dense small aggregation on the second transect of the *Lady Noreen* showed up on the density plots at 90m appeared to be most likely biomass rather than bottom topology or a large boulder.
- Sampling data using 27 catch weighted fishery samples collected on October 8-9 had a mean size of 26.2cm and average weight of 130g (Figure 34). These samples were used in TS calculation with adjustment for frequency of the echo sounder.
- Initial analysis of 25,768t by A. Clay for the overall area (standard TS for 28cm, with CIF). The final total biomass estimate of 21,475t (calculated with CIF) for the surveyed area of 812km^2 with19,848t within the box and 1,627t outside the box.
- Analysis by depth layer for transects within the survey box area showed 21.4% of the total biomass within the zone 0-5m off bottom and only 4.8% in the 1-2m depth zone (Figure 35).

German Bank Acoustic Survey #6: October 23, 2012

- This survey did not follow protocol and was completed by one boat with an acoustic system on one school of fish (Figure 36). Given that this survey was conducted on a school of spawning fish, it was included in the biomass estimate.
- Two fishery samples, available from October 25, had a mean size of 26.9cm and average weight of 147g (Figure 37). These samples were used in TS calculation with adjustment for frequency of the echo sounder.
- Initial analysis by A. Clay of 7,069t (using standard TS; with CIF) applied to an area of 0.53km^2. The final analysis had a total biomass estimate of 6,303t (calculated with CIF) for the area of 0.38 km^2 using the fishery sample generated TS.
- Analysis by depth layer for transects within the survey box area showed 18.3% of the total biomass was found within the zone 0-5m off bottom with a peak of 5.4% in the 3-4m and 4-5m depth zones (Figure 38).

2012 German Bank Acoustic Surveys Summary

In 2012, six structured surveys conducted between August 12 and October 24 were used to determine a spawning biomass estimate of 278,296t within the survey box and 10,147t outside the box. This resulted in an overall survey biomass estimate of 288,443t.

Spectacle Buoy

The spring gillnet fishery for roe has usually occurred for a short period in June in the vicinity of Spectacle Buoy located just southwest of Yarmouth, Nova Scotia. The fishery is dependent upon the availability of fish and to some extent market conditions, and may or may not occur in any given year. In 2008, there was virtually no fishery with only one landing of 6t. Two acoustic surveys were undertaken in 2008 but very little fish was recorded. In previous years, herring in this area were believed to have occurred in greater abundance in late May-early June. It is assumed the surveys had missed the majority of fish, but there were no other signs or reports of herring in 2008. In 2009, there was little fishing (<1t) and no survey activity in this area.

There were no catches reported in 2010, and only 1t reported in 2011. Again in 2012, there were no reported catches (Table 6). Only one survey was completed in 2011 on May 25 (Figure 39) with a biomass estimate of 282t (Table 7). There were no surveys conducted in 2012 in the Spectacle Buoy area.

Trinity Ledge

In previous years, the surveying of spawning herring on Trinity Ledge has been considered to be less than optimal, and it is unlikely that biomass estimates accurately reflect the abundance of fish in this area (Power et al. 2007). Improvements to the survey approach and adherence to the design protocols are required if the data are to reflect trends in abundance.

In 2010, catches of 202t were recorded from August 11 to September 24, and the total overall survey biomass for Trinity Ledge in 2010 was 2,405t as calculated with the CIF (Table 6). Maturity samples in 2011 indicated there were mostly immature fish present on August 16 (Figure 40A); and, in 2012, there were immature fish present on August 17 and 21 (Figure 40B). This was less evident in the length frequency samples (Figure 41A,B); however, the first length frequency sample in the 2012 was on August 25 (Figure 41B).

In 2011, catches of 638t were recorded from August 9 to September 20 (Table 6) and the total overall survey biomass estimate was 7,316t from three surveys conducted on August 7 (982t, see Figure 42A for transects and Figure 45 for multi-panel sample details), August 31 (3,194t, see Figure 43A) and Figure 46 for multi-panel sample details), and September 12 (3,140t, see Figure 44A and Figure 47 for multi-panel sample details). Table 8A show details of the biomass estimates of the three survey transects conducted in 2011.

In 2012, catches of 448t were recorded from August 15 to September 18 (Table 6), and the total overall survey biomass estimate was 2,754t from three surveys conducted on August 7 (53t, see Figure 42B), August 23 (894t, see Figure 43B) and September 3 (1,807t, see Figure 44B). There were no multi-panel samples in 2012. Table 8B show details of the biomass estimates of the three survey transects conducted in 2012.

Figure 48 presents the catches and the survey biomass estimates from 1998 to 2012 for Trinity Ledge.

Browns Bank

There was no survey activity on Browns Bank in 2011 or 2012.

Seal Island

Historically, the spawning areas around Seal Island made a significant contribution to the biomass of the Bay of Fundy/SWNS stock complex. In recent years, the abundance of herring and the documentation of spawning fish in this area have been intermittent. In addition, little fishing has occurred in these shallow grounds, partly as a result of the deep purse seines that are now being employed, which are unsuitable for fishing these areas.

A survey was conducted on September 21, 2011, in the area, with an initial biomass estimate of 2353t for the Seal Island area. This amount was later revised to 1472t after applying the sample TS (see Figure 27A). No survey was conducted in the area in 2012.

Bay of Fundy/Southwest Nova Scotia (SWNS) Summary

Since 1997, biomass estimates determined from acoustic surveys have been used to evaluate the status of the Bay of Fundy/SWNS component of the 4WX herring stock complex. During this time, the approach for estimating SSB has evolved to reliance on structured surveys scheduled at 2-week intervals. Since 1999, spawning areas were defined and survey protocols were established to make the estimates more representative of the actual SSB rather than a minimum observed value. This required a series of surveys that covered most of the spawning area on each of the spawning grounds during the defined spawning season.

The SSB for the Bay of Fundy/SWNS component of the 4WX herring stock complex in 2011 and 2012 were determined from industry based acoustic surveys of the three major spawning components: Scots Bay, Trinity Ledge, and German Bank. Historical timing of surveys and biomass estimates for Scots Bay and German Bank are presented in figures 49 and 50. There was one structured survey conducted outside the main spawning area around Seal Island in 2011, but none was completed in the vicinity of Browns Bank. Acoustic data from fishing nights were not included in the biomass estimate for any of the spawning components. There was limited fishing and only one survey conducted in 2011 in the Spectacle Buoy area during the spring spawning period. No fishing or surveying was done in 2012 in the Spectacle Buoy area.

The 2011 and 2012 acoustic results provide estimates of herring present at the time of surveying when conducted according to the survey design. A major source of uncertainty continues to be the assumption that the surveys are simply additive. If herring do not move on and off the spawning grounds in waves with a short period of time (days) between the waves, the estimate of total SSB will be significantly biased upward due to double counting. The issue of turn-over time and potential overlap (multiple counting) was evaluated at the SAP Framework review meetings in 2006/2007 (DFO 2007), and the 10-14 day time period between surveys was considered reasonable, but required further investigations. The investigation into turnover using tagging studies was presented by Maxner et al. (2010) and summarized the 2010 German Bank turn-over tagging experiment results. Melvin et al. (2014b) presented further data and analyses on these studies.

The SSB for Scots Bay reached a high of 163,900t in 2001, and showed a major decline in 2005 (Figure 49), likely due in part to the excessive catches of 2004 and 2005 (Power et al. 2010). Since the low in 2005, Scots Bay has shown a slight improvement increasing from 21,200t to 52,700t in 2007. In 2008, there was a substantial decline, with an area estimate of 23,400t (Table 9). In 2009, the surveyed biomass increased to 87,700t, but declined again in 2010 to 54,000t. In 2011, there was a 3-fold increase in the SSB to 140,712t and a further increase to 184,829t in 2012, taking the SSB to above the long term average (Figure 51).

The total German Bank biomass was estimated to be 300,461t in 2011 and 288,443t in 2012. Structured surveys used in the estimation covered the period from August 26 to October 10 in 2011 and August 12 to October 24 in 2012 (Table 5). The 2011 German Bank spawning biomass estimate represents an increase of 46,661t (or 18%) over the 2010 estimate, while the

2012 estimate represents a 4% decrease (by 12,018t) from the 2011 biomass estimate (Table 9). The SSB for the last three years remain below the long term average (Figure 51).

The increase in spawning biomass observed on Trinity ledge in 2010 (2,400t from 1,600t in 2009) was also observed in 2011 (7,300t), taking it above the 1999-2012 average of 6,976t (Table 9). However, this increase did not carry through to 2012 with the estimate dropping to 2,800t, well below the long term average. The total observed biomass in 2011 from three surveys was 7,315t (Table 8A). In 2012, the three surveys resulted in an estimate of 2,754t. In both years, only one vessel conducted the surveys.

Trinity Ledge once supported a large spawning component and fishery within the 4WX stock complex. Since the observed biomass is still low, any fishing on Trinity Ledge must strictly adhere to the "survey, assess, then fish" protocol during the upcoming spawning season. Thus, no fishing should occur until sufficient quantities of herring are observed to allow for removals. Alternatively, given the slow rate of recovery, consideration should also be given to complete closure until a significant increase in spawning biomass is observed.

Surveys around Spectacle Buoy are intermittent and only occur when herring are discovered in the area. There were 32 surveys in 2010 with a biomass estimate of 1,859t and only one in 2011 with a biomass estimate of 282t but none in 2012 (tables 7 and 9).

The lowest total SSB for the Bay of Fundy/SWNS spawning complex in the time series was estimated to be 264,900t in 2008 (Table 9; Figure 52). Since 1999, the total SSB has fluctuated between 264,000t and 550,000t. While the 2010 estimated biomass was the third lowest in the time series at 312,100t, both of the estimates in 2011 and 2012 have trended upwards (448,8001t in 2011 and 476,000t in 2012). This represents an increase of 44% from 2010 to 2011 and an increase of 16% from 2011 to 2012. These last two years have seen an increase above the long term average (Figure 52). It is evident that most of this increase is occurring in the Scots Bay area and may be related to the industry imposed catch restriction of 5,000t in Scots Bay. Caution is still warranted in establishing removals for these stock components since even though the spawning biomass seem to be recovering the recovery time period is small.

COASTAL NOVA SCOTIA SPAWNING COMPONENT

The shallow inshore waters of the bays and inlets along the Atlantic coast of Nova Scotia support a number of herring spawning populations. Several documents describe reports of coastal spawning in 4VWX (Clark et al. 1999; Crawford 1979). Direct knowledge of these relatively small coastal populations is limited to a few areas where there are active commercial fisheries for roe on spawning grounds. A traditional fishery for lobster bait occurs in the spring and summer of the year. In the fall, commercial roe fisheries have been conducted in three areas of the Nova Scotia coastal stock component: Port Mouton/Little Hope, Halifax/Eastern Shore and Glace Bay. Surveys of the spawning grounds were undertaken using both the mapping and the structured acoustic survey approach, depending upon the area and the availability of a recording vessel.

The results for each spawning area presented below are calculated only with the CIF, which is considered to provide a more accurate representation of biomass. This method of calculation has been applied since 2003 and can now be used for the consistent calculation of five year averages, which are used to establish beginning of year allocations for each area.

Little Hope/Port Mouton Surveys

2011 Little Hope/Port Mouton Acoustic Surveys

The 2011 herring gillnet fishery in Little Hope/Port Mouton area began on September 15 and extended to November 8. The total catch of 2,576t in 2011 represents a decrease from 3,106t in

2010 (Figure 53), with the majority of the catch occurring between September 15 and October 24 (Figure 54). The catches occurred in three main areas off Port Mouton, near Liverpool and Port Medway (Figure 55A). Overall in 2011, six acoustics surveys were conducted in the Little Hope/Port Mouton area between September 17 and October 28. All data were downloaded from the two boats with an acoustic recorder and, after editing to remove the bottom and non-herring targets, the acoustic files were cut into transects for each survey.

Since the multi-panel gillnet was not used for all surveys to sample the acoustic targets in 2011, the standard TS of -35.96 for a 120 kHz system was used for all surveys where direct samples were not available to estimate biomass from the backscatter. Length frequency and biological samples from the commercial catch were only used to confirm the size and maturity of herring in the area (figures 56A and 57A). The lack of good sampling for acoustic surveys in this area remains a problem that needs to be addressed. The use of standard TS likely underestimates the average size of herring surveyed with acoustics and may also underestimate the overall biomass.

Little Hope Acoustic Survey #1 - September 17, 2011

The first survey in 2011 for the Little Hope spawning area was conducted by a single acoustic survey vessel (Figure 58A). There was very little fish encountered in the two schools surveyed and as a result this survey was removed from the biomass estimate. Additionally, there were no multi-mesh experimental gillnet samples collected for length frequency. There was also a mapping survey by 12 gillnet vessels using paper data sheets to record observations from their sounders. They covered more of the area than was covered by the acoustic survey vessels. This data has not been analysed.

Little Hope Acoustic Survey #2b – September 27, 2011

The second herring acoustic survey in 2011 for the Little Hope spawning area was conducted with two acoustic survey vessels. The acoustic vessels conducted separate fine scale systematic parallel transect surveys in four distinct areas (Figure 59A) with three of those areas being surveyed twice. There was also a mapping survey by 14 gillnet vessels using paper data sheets to record observations from their sounders. They covered more of the area than was covered by the acoustic survey vessels. This data has not been analysed as yet.

Biological samples were collected using the multi-panel gillnet for length frequency and maturity to confirm spawning condition (figures 56A and 57A). Biomass estimates were based on TS for a weighted mean length of 26.7cm fish (Figure 61A). The size and maturity of herring from the commercial roe fishery in the area also confirmed the presence of spawning fish (figures 56A and 57A). The total biomass from the schools surveyed was estimated to be 3,250t with the CIF (Table 10A).

Little Hope Acoustic Survey #3 – October 7, 2011

The third acoustic survey in 2011 for the Little Hope spawning area was conducted by two acoustic survey vessels. The vessels conducted four separate fine scale systematic parallel transect surveys (Figure 62) on nine separate schools. The lines were not predefined by a survey design, but rather were conceived based on the best coverage of the aggregations. There was also a mapping survey by 17 gillnet vessels using paper data sheets to record observations from their sounders. They covered more of the area than was covered by the acoustic survey vessels. This data has not been analysed.

No biological samples were available to estimate TS so the standard TS for a 28cm herring was used. The size and maturity of herring from the commercial roe fishery in the area later confirmed the presence of spawning fish (Figure 56A,B). The total biomass from the schools surveyed was estimated to be 12,748t with the CIF (Table 10A).

Little Hope Acoustic Survey #4 - October 18, 2011

The fourth survey for the Little Hope spawning area was conducted by one acoustic survey vessel on six separate schools of fish (Figure 63). No biological samples were available to estimate TS so the standard TS for a 28cm herring was used. The biomass estimate for the survey was 8,995t (Table 10A).

There was also a mapping survey by 10 gillnet vessels using paper data sheets to record observations from their sounders. They covered more of the area than was covered by the acoustic survey vessels. This data has not been analysed.

Little Hope Acoustic Survey #5 - October 23, 2011

The fifth acoustic survey for the Little Hope spawning area was conducted by a single acoustic survey vessel and was excluded from the analysis because the same fish that was surveyed on October 18 was surveyed again in the same areas. This survey was conducted only five days after the survey of October 18 and was excluded from the total biomass estimate. Also, no samples were collected for length frequency. The total biomass was estimated to be 7,641t as calculated with the CIF (Table 10A). The results from this survey were not included in the total SSB estimate.

Little Hope Acoustic Survey #6 - October 28, 2011

The sixth herring acoustic survey in 2011 for the Little Hope spawning area was conducted with two acoustic survey vessels. The acoustic vessels conducted separate fine scale systematic parallel transect surveys in four distinct areas (Figure 64). There was also a mapping survey by nine gillnet vessels using paper data sheets to record observations from their sounders. They covered more of the area than was covered by the acoustic survey vessels. This data has not been analysed.

Biological samples were collected using the multi-panel gillnet for length frequency and maturity to confirm spawning condition (Figure 65). Biomass estimates were based on TS for a weighted mean length of 29.1cm fish. The total biomass from the schools surveyed was estimated to be 3,803t with the CIF (Table 10A).

2011 Little Hope Summary

In 2011, six acoustic surveys were conducted in the Little Hope/Port Mouton spawning box over the traditional spawning period. The standard protocol for surveying spawning herring of allowing 10-14 days between surveys was followed in order to avoid double counting that may have remained from the previous surveys. Using this criterion, five of the surveys were considered for estimating the total SSB. The fifth survey was excluded because of its timing and proximity to the fourth survey. Survey number six was included in the total spawning biomass estimate.

Summing of the biomass from all valid surveys/schools resulted in a total spawning biomass of 28,796t (Table 10A), an increase from the 2010 estimate of 26,700t, and just above the long term average of 25,263t (Table 14). The spawning biomass in the Little Hope spawning box now appears to be around the long term average, improving from the low in 2007 (Figure 66).

2012 Port Mouton/Little Hope Acoustic Surveys

In 2012, the Port Mouton/Little Hope herring gillnet fishery landed a total of 2,150t with the largest proportion being taken within the spawning box (Figure 55B). As in previous years the majority of the landings were reported in September (958t) and October (1,191t). This represents a 16% reduction in landing from 2011 (2,563t). Catches were distributed from southwest of Port Mouton to mid-way between Liverpool and Port Medway at five general locations (Figure 55B).

This was a year of transition from one acoustic gear type to another (HDPS to Simrad ES70) and with it came a number of implementing challenges. One of the main differences between the acoustic systems was the automated change in sounder parameters (pulse length and ping rate) to optimize the detection of fish. Ping rates of up to 10 pings/sec and a pulse length of 0.056ms, which varied with depth, represented a large deviation from the standard of one ping per second and a pulse length of approximately 1.0ms. Calibrations were only conducted for the standard settings. The challenge with the new sounder (ES70) was to fix the ping rate and pulse length. It was estimated that a small correction 0.3-0.5 dB would be required to adjust for the pulse length difference. Setting the sounder settings to fixed values was a challenge, with the first survey using the variable settings and the second fixed settings. The solution was to use the ES60 logging software with fixed setting. Only two acoustic surveys were conducted within the spawning box during 2012, although a number of excursions were undertaken to test the new equipment.

Traditionally, the estimated TS for Little Hope herring was based on the standard of -35.5 for a 28cm fish due to the lack of appropriate sampling. In 2012, the multi-panel gillnet was used to collect samples during or near the surveys days. The industry is to be commended for their efforts in collecting these samples and it is hoped that the practice will continue into the future. The multi-panel gillnet was deployed on September 25 and October 9. Length frequency data were used to estimate the mean length of fish present along with the preserved/processed samples. Length frequencies are weighted by the catch for each mesh size. The distributions of fish caught by each mesh size are presented in figures 60 and 61B. For September 25, the weighted mean length was 27.8cm and the mean weight (163g) for a TS of -35.581, including the adjustment for frequency. The October 9 sample weighted mean length was 27.9cm and mean weight of (164g) for a TS of –35.585. Both TS estimates were adjusted for the 120 kHz frequency (Table 10B). It should be noted that there are a large number of smaller fish in the distribution for both sampling nights, which is unusual for this area and could indicate a good recruiting year-class.

Little Hope Survey # 1 – September 24, 2012

The first 2012 survey in the Little Hope area was conducted by the *Atlantic Star* using a Simrad ES70 to estimate herring biomass of two schools separated by a distance of 11km (Figure 58B). The vessel followed the defined survey method and conducted vertical (3) and horizontal transects (4) over the fish school. The small number of transects for each direction resulted in relatively high error estimates around the mean. Unlike the HDPS system both the ES60 and ES70 echo-sounders have a manufacturer induced systematic error (triangular wave) ranging from -1 to +1 dB applied to the backscatter. This error was removed from both the calibration and data files prior to analysis using ES60 Adjust software.

The first survey was undertaken before the echo-sounder settings could be fixed to the standard pulse length and ping rate. This resulted in a ping of 9-10 pings per second and data collections far in excess of the normal rate, consequently the original data file was resampled every 8-10 pings to make the sampling effort more consistent with other acoustic survey data collections. Although there will be an effect of a shorter and changing pulse length, the data were analysed using the standard setting calibration file. Based on observed changes in gain and Sa calibration settings for reduced pulse length in other studies, it is estimated that the biomass for Little Hope survey #1 could be underestimated by 10-15%.

The biomass estimated for school 1 varied from 6,445t to 8,997t with a standard error (SE) of 50-71% depending upon the direction of surveying (Table 10B). In this case, the horizontal transects were deemed the most appropriate given the smaller area and lower error estimate. The biomass estimate for school 1 was 8,997t. For school 2, the three transects in an area of

1.031km^2 produced an estimate of 3,083t. The total spawning biomass for the September 23 survey was 12,080t.

Little Hope Survey # 2 – October 10, 2012

The second Little Hope/Port Mouton survey was conducted on the night of October 10, 2012, on a single school located in approximately the same location as school 1 in the first survey (Figure 59B). Again, the multi-panel gillnet provided samples of fish size, which were not significantly different from the initial sample, and resulted in very similar TS (Figure 61B). The standard setting of 1 ping per second and a pulse length of 1,024ms was used during the survey so the calibration was valid. The single school covered a much broader area (3.6 km^2), but was less dense than observed in September. The total biomass estimated from 12 transects was 676t (Table 10B).

The total 2012 SSB for the Little Hope/Port Morton spawning box, without adjustment for the sounder settings, was 12,756t. It is likely that this represents a slight underestimate (10-15%) due to the shorter pulse length and rapid ping rate for the first survey. Regardless it represents a significant reduction (great than (>)50%) from the 2011 biomass estimate of 28,939t (Table 14).

2012 Little Hope Summary

Summing the biomass from all the valid surveys/schools resulted in a total spawning biomass of 12,756t (Table 10B), which was less than half of the 28,796t estimated in 2011, and well below the long term average of 25,263t.

As in previous years, there are several remaining issues with survey methods and protocols for the Little Hope area that need to be addressed in the coming season. There is a need for the acoustic system to be calibrated and for the continued collection of good multi-panel gillnet samples to estimate the size and maturities of the herring being surveyed. Consideration should also be given to the extent of the survey area and what should be considered valid as part of the overall biomass estimate for the season. Biomass estimates are based on only fish observed in the spawning box.

Halifax/Eastern Shore Fishery and Surveys

2011 Eastern Shore Acoustic Surveys

In 2011, acoustic surveys were completed in each of the primary fishing areas from Halifax Harbour to near Ship Harbour, Nova Scotia, on September 22, October 3, and October 8 with a camera survey on October 19 (Table 11A). The data were downloaded from the three boats with acoustic recorders, *Bradley K, TBS* and *Miss Owls Head*. In 2011, one multi-panel gillnet sample was collected for each of the surveys resulting in the generation of survey-specific TSs. The maturity samples showed a high proportion of ripe and running (Stage 6) fish ranging from 91% to 100% at the time of each survey (Figure 70A). Sampling for size using fishery nets, with 2¾" mesh and multi-panel nets with mesh sizes of 1⅞", 2⅜", 2½" and 2¾", showed the presence of fish smaller than 30cm early in the season, but less so after October 4 (Figure 71A).

The 2011 herring gillnet fishery in the Eastern Shore fishing area began on September 21 and ended on October 12, with total landings of 1,040t compared with 2,456t in 2010 (Table 14; figures 67 and 69A). Most catches occurred between September 23 and October 9 (Figure 68). Once again, this was primarily a herring roe fishery with catches reported from three main areas: near Halifax Harbour approaches, southwest of Jeddore Head, and south of Ship Harbour. Catches were well distributed throughout the spawning box, catches were concentrated near the approaches to Halifax Harbour south of Ship Harbour (Figure 69A).

Halifax/Eastern Shore Acoustic Survey #1 - September 22, 2011

The first survey for the 2011 season was conducted by three acoustic survey vessels (Figure 72). The lines were not predefined by a survey design, but rather were conceived based on the best coverage of the aggregations using equally spaced parallel lines. Three schools were observed and surveyed in the western section of the survey box (Figure 72). The entire survey box was covered by 13 non-recording vessels, but that data was not analysed.

A multi-panel gillnet sample for the western school was taken on September 23 and processed for both maturity stage and size (Figure 73). The overall size caught ranged from 24.5-34.0cm, with 23.2% larger than 30cm. The weighted mean length of herring (28.6cm) from the multi-panel net with panel mesh sizes from 1⅞" to 2¾" was used for the calculation of TS (Figure 73). Nearly all fish sampled (97%) were found to be in ripe and running spawning condition (Stage 6) (Figure 70A). The total spawning biomass from the three schools surveyed was estimated to be 2,541t as calculated with the CIF (Table 11A).

Halifax/Eastern Shore Acoustic Survey #2 - October 3, 2011

This survey was conducted 11 days after the first survey by one acoustic survey vessel, the *Bradley K*. The vessels conducted a fine scale systematic parallel transect survey on two aggregations of spawning herring (Figure 74). The survey tracks were not typical due to the lack of equally spaced parallel lines; however, some parallel lines were extracted from the survey and used to determine the biomass. A multi-panel sample was collected and processed (Figure 75A). The multi-panel net primarily caught fish from 24.0 to 32.5cm in the panel mesh sizes 2½" and 2¾" although at least one fish was also caught by the smaller mesh panels. The weighted mean length of 29.9cm for the combined panels was used for the calculation of TS (Figure 75A). All of the fish sampled (100%) were found to be in ripe and running spawning condition (Stage 6) (Figure 70A).

The total biomass from the two aggregations surveyed on October 3 was estimated to be 112t as calculated with the CIF (Table 11A).

Halifax/Eastern Shore Acoustic Survey #3 – October 8, 2011

The third survey conducted on October 8-9 found four aggregations of spawning herring: one, east of Halifax Harbour and three, south of Owls Head. This survey was undertaken only five days after the second survey by three acoustic survey vessels (Figure 76A). The lines were not predefined by a survey design, but rather were conceived based on the best coverage of the aggregations. Given the absence of observed fish, no mapping boats were involved in the survey (Table 2A). A multi-panel sample was collected during this third survey, and biomass estimates were based on 31.1cm weighted mean length and a mean weight of 232g using the TS adjustment for frequency (Figure 77A). The biomass estimate for surveyed schools was 2,845t, and was used in the estimate of spawning biomass because there were identified in different areas than in the previous survey (Table 11A).

Halifax/Eastern Shore Acoustic Survey #4 - October 19, 2011

This was a camera survey and not used in the estimation of survey biomass.

Halifax/Eastern Shore Acoustic Survey Summary for 2011

The 2011 acoustic surveys in the Halifax/Eastern Shore provided good coverage of the various herring spawning locations in the survey area. As usual, the surveys were supported by a multi-panel gillnet to collect representative samples of herring being surveyed on each of the survey nights to better estimate TS. Unfortunately, there was a general absence of herring especially during the latter part of the season (Table 11A; Figure 68).

The total spawning biomass for the Eastern Shore area for 2011 was taken as the sum of the September 22, October 3 and October 8 surveys, where there was not an overlap in either the 10 day time window or location (Table 11A). The total spawning biomass estimate was 5,498t with the CIF. This represents a further decline from the 2009 high estimate of 54,200t in spawning biomass (Table 14; Figure 78). This 2011 estimate of 5,498t represents the lowest observed biomass since surveys started in 1998 for this area.

2012 Eastern Shore Acoustic Surveys

The 2012 herring gillnet fishery in the Eastern Shore fishing area began on September 1 and ended on October 28 with total landings of 799t compared with1,040t in 2011 (Table 14; figures 67 and 69B). Most catches occurred between September 18 and October 28 (Figure 68). Once again, this was primarily a herring roe fishery with catches reported from three main areas: near Halifax Harbour approaches, southwest of Jeddore Head and south of Ship Harbour. Catches were concentrated near the approaches to Halifax Harbour and south of Ship Harbour (Figure 69B). In 2012, two surveys were completed one on October 3 and the other on October 26 (Table 11B).

The data were downloaded from two boats with acoustic recorders, *Bradley K* and *Miss Owls Head*. Sampling was good in 2012 with one multi-panel gillnet sample collected for each of the two surveys. The maturity samples showed a high proportion of ripe and running (Stage 6) fish ranging from 66% to 72% at the time of each survey (Figure 70B). Sampling for size using fishery nets, with 2¾" mesh and multi-panel nets with mesh sizes of 1⅞", 2⅜", 2½" and 2¾", showed the presence of fish smaller than 30cm early in the season but less so after October 4 (figures 75B and 77B).

Halifax/Eastern Shore Acoustic Survey #1 – October 3, 2012

The first survey of the 2012 season was conducted by two acoustic survey vessels (Figure 74B). The lines were not predefined by a survey design, but rather were conceived based on the best coverage of the aggregations using equally spaced parallel lines. One school was observed and surveyed.

Multi-panel gillnet samples were taken for both surveys for maturity stage and size. Ripe and running (Stage 6) fish comprised 72% of the sample (Figure 70B). The overall size caught ranged from 23.5 to 33.5cm, with 27% larger than 30cm (Figure 71B). The weighted mean length of herring (29.3 cm) from the multi-panel net with panel mesh sizes from 1⅞" to 2¾" was used for the calculation of TS (Figure 75B). The total spawning biomass from the school surveyed was estimated to be 1,544t as calculated with the CIF (Table 11B).

Halifax/Eastern Shore Acoustic Survey #2 – October 26, 2012

The second survey of the 2012 season was conducted by one acoustic survey vessel (Figure 76B). The lines were not predefined by a survey design, but rather were conceived based on the best coverage of the aggregations using equally spaced parallel lines. One school was observed and surveyed in the survey.

Multi-panel gillnet samples were taken for both surveys and maturity stage and size indicating that 81% were hard (Stage 5) at the time of the sampling (Figure 70B). The overall size caught ranged from 24 to 34cm, with 54% larger than 30cm (Figure 71B). The weighted mean length of herring (27.8cm) from the multi-panel net with panel mesh sizes from 1⅞" to 2¾" was used for the calculation of TS (Figure 77B). The total spawning biomass from the school surveyed was estimated to be 2,124t as calculated with the CIF (Table 11B).

Halifax/Eastern Shore Acoustic Survey Summary for 2012

There were only two acoustic surveys in the Halifax/Eastern Shore area in 2012. As usual, the surveys were supported by a multi-panel gillnet to collect representative samples of herring being surveyed on each of the two survey nights to better estimate TS.

The total spawning biomass for the Eastern Shore area for 2012 was taken as the sum of the two surveys (Table 11B). The total spawning biomass estimate was 3,668t with the CIF. This represents a further decline from the 2009 high estimate of 54,200t in spawning biomass (Table 11B; Figure 78). It is also the lowest observed biomass since surveys started in 1998 for this area and follows the previous low of 5,498t in 2011 (Table 14).

The 2011/2012 results are considered to provide a reasonable estimate of herring present at the time of surveying. A major concern or source of uncertainty is the assumption that the surveys are simply cumulative. If herring do not move 'on to' and 'off of' the spawning grounds in waves, the estimate of total SSB will be significantly biased upward due to double counting. Another major issue, which was addressed at the 2007 Herring Framework review, is the use of these estimates as absolute measures of biomass due to the many uncertainties, especially with TS.

Although no spawning surveys were conducted between Liverpool and Chebucto Head, commercial landings during the spawning season in 2011 and 2012 were reported from the area (Table 12). Further investigation of the area is required to determine if herring are spawning in the area or just in transit to other spawning grounds.

Glace Bay Fishery and Surveys

2011 Glace Bay Acoustic Surveys

Survey coverage for the Glace Bay area was poor in 2011, with five surveys attempted between September 15 and October 22; however, only the survey done on September 15 found fish. There was an absence of fish in the other surveys (Table 13). There was no spawning fishery in 2011 in the area due to a lack of markets and/or the absence of fish. The lack of fishing activity may have prevented the opportunity for other boats to participate in the searching and survey activities.

Glace Bay Acoustic Survey #1 – September 15, 2011

This survey was conducted by a single acoustic survey vessel, *Natasha Lee*, which undertook a broad scale systematic parallel transect survey over a 38.7km^2 area of the Glace Bay spawning box, where herring were traditionally observed (Figure 80). The overall layout of the transects was good but, consistent with previous years, very few fish were observed. The biomass for the overall survey was estimated to be 51t as calculated using the standard TS of -35.96 for a 120 kHz with the CIF (Table 13).

Glace Bay Acoustic Survey Summary for 2011

Survey coverage for the Glace Bay area was poor in 2011 with only one survey detecting fish out of five searches that were completed throughout the entire spawning season. Virtually no herring were observed other than the one survey with a total biomass estimate of 51t. This represents the second lowest observed biomass since 2006 when no surveys were conducted (Figure 81). In addition, no biological samples were collected, and there was no fishery in the area for 2011. Improvements in the survey timing, location and amount of survey effort are required in the future for this area.

2012 Glace Bay Acoustic Surveys

There was no acoustic surveys conducted in the area in 2012 and a 7t catch was reported for 2012 (Table 14; Figure 81).

Overall Coastal Nova Scotia Spawning Component

Landings and spawning biomass have fluctuated annually in the Little Hope/Port Mouton area, with SSB increasing from a low in 2008 to around the average in 2010 and 2011, and then dropping about 50% below the average in 2012 (Table 14; Figure 66). The Halifax/Eastern Shore area has also shown several ups and downs in SSB, with the 2012 SSB being the lowest since 2001 (Figure 78). Landings depict a similar pattern, except they took a marked increase and peaked in 2009. Landings were slightly above the long term average in 2010 (Table 14; Figure 78). For the Glace Bay area, there have been essentially no landings since 2005, partly due to availability and partly due to markets. Annual surveys in the area could not find any significant aggregations of spawning herring since about the same time (Table 14; Figure 81). Small catches (142t in 2011 and 34t in 2012) are also being taken along the coast from Liverpool to Chebucto Head (Table 12; Figure 79).

Offshore Scotian Shelf Component

Fleet activity/catch in the spring/early summer fishery on the offshore banks of the Scotian Shelf has varied between 1,000t and 20,000t since 1996 with landings of 5,263t in 2005. In 2011, fishing occurred from May 15 to June 9 with 10,455t catch being reported. In 2012, fishing occurred between April 16 and June 3, with 1210t catch reported. Fishery samples in 2011 and 2012 show that most of the fish were Stage 3 (Figure 82A,B). Length frequency samples also indicate that most of the fish in the 2011 and the 2012 samples were larger than 23cm (Figure 83A,B). No acoustic biomass estimates were available from the Scotian Shelf in 2011 and 2012. There continues to be a lack of herring research on the Scotian Shelf in the fall. A research vessel platform (such as the CCGS *Alfred Needler*) is needed to investigate possible spawning activity in the offshore areas.

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TABLES

Table 1. Summary of the number of surveys undertaken in 2011 and 2012, as well as the number of fishing nights examined in the estimation of SSB for the 4VWX stock and coastal component complexes.

	2011		2012	
Spawning Ground	Surveys Completed	Fishing Nights	Surveys Completed	Fishing Nights
Offshore Banks	0	0	0	0
Scots Bay	6	4	5	0
German Bank	5	0	6	0
Spectacle Buoy	1	0	0	0
Trinity Ledge	3	0	3	0
Little Hope	6	0	2	0
Eastern Shore	4	0	2	0
Glace Bay	1	0	0	0
Total	26	4	18	0

Table 2A. Summary of completed herring acoustic surveys undertaken in 2011 with interval (days) between surveys on the same grounds, number of boats with acoustic systems, and the number of mapping boats (without acoustic systems using deck sheets only). 'n/a' indicates not applicable.

No.	Survey Date	Location of Survey	Interval (days)	Acoustic Boats	Mapping Boats	Total No. Boats
1	25-May-11	Spec Buoy #1	0	1	0	1
2	02-Jul-11	Scots Bay #1	0	6	0	6
3	16-Jul-11	Scots Bay #2	14	6	0	6
4	30-Jul-11	Scots Bay #3	14	7	0	7
5	13-Aug-11	Scots Bay #4	13	6	0	6
6	26-Aug-11	Scots Bay #5	13	6	0	6
7	25-Sep-11	Scots Bay #6	29	1	0	1
s1	13-Jul-11	Scots Bay Scout Night #1	0	1	n/a	n/a
s2	27-Jul-11	Scots Bay Scout Night #2	14	1	n/a	n/a
s3	10-Aug-11	Scots Bay Scout Night #3	13	1	n/a	n/a
s4	24-Aug-11	Scots Bay Scout Night #4	14	1	n/a	n/a
8	07-Aug-11	Trinity Ledge #1	0	1	5	6
9	31-Aug-11	Trinity Ledge #2	24	1	0	1
10	12-Sep-11	Trinity Ledge #3	12	1	0	1
11	26-Aug-11	German Bank #1	0	6	0	6
12	08-Sep-11	German Bank #2	12	8	0	8
13	21-Sep-11	German Bank #3	13	10	0	10
14	10-Oct-11	German Bank #4	19	5	0	5
15	23-Oct-11	German Bank #5	13	6	0	6
1	21-Sep-11	Seal Island	0	1	0	1
1	17-Sep-11	Little Hope #1	0	1	12	13
2	23-Sep-11	Little Hope #2a	6	2	0	2
3	27-Sep-11	Little Hope #2b	4	2	14	16
4	07-Oct-11	Little Hope #3	10	2	17	19
5	18-Oct-11	Little Hope #4	11	2	10	12
6	23-Oct-11	Little Hope #5	5	1		1
7	28-Oct-11	Little Hope #6	5	1	9	10
1	22-Sep-11	Eastern Shore #1	0	3	13	16
2	03-Oct-11	Eastern Shore #2	11	1	0	1
3	08-Oct-11	Eastern Shore #3	5	3	0	3
4	19-Oct-11	Eastern Shore #4	11	1	0	1
1	15-Sep-11	Glace Bay #1	0	1	0	1
2	22-Sep-11	Glace Bay #2	7	1	0	1
3	29-Sep-11	Glace Bay #3	7	1	0	1
4	09-Oct-11	Glace Bay #4	10	1	0	1
5	22-Oct-11	Glace Bay #5	13	1	0	1
Total number of survey boat nights				100	80	180

Table 2B. Summary of completed herring acoustic surveys undertaken in 2012 with interval (days) between surveys on the same grounds, number of boats with acoustic systems, and the number of mapping boats (without acoustic systems using deck sheets only).

No.	Survey Date	Location of Survey	Interval (days)	Acoustic Boats	Mapping Boats	Total No. Boats
2	30-Jun-12	Scots Bay #1	0	11	0	11
3	14-Jul-12	Scots Bay #2	14	11	0	11
4	28-Jul-12	Scots Bay #3	14	10	1	11
5	11-Aug-12	Scots Bay #4	13	8	0	8
6	25-Aug-12	Scots Bay #5	14	7	0	7
s1	20-Jun-12	Scots Bay Scout Night #1	0	1	0	1
s2	27-Jun-12	Scots Bay Scout Night #2	7	1	0	1
s3	11-Jul-12	Scots Bay Scout Night #3	14	1	0	1
s4	24-Jul-12	Scots Bay Scout Night #4	13	1	0	1
s5	08-Aug-12	Scots Bay Scout Night #5	14	1	0	1
7	07-Aug-12	Trinity Ledge #1	0	1	0	1
8	23-Aug-12	Trinity Ledge #2	16	1	0	1
9	03-Sep-12	Trinity Ledge #3	10	1	0	1
10	12-Aug-12	German Bank #1	0	6	0	6
11	26-Aug-12	German Bank #2	14	7	0	7
12	09-Sep-12	German Bank #3	13	12	1	13
13	22-Sep-12	German Bank #4	13	8	0	8
14	07-Oct-12	German Bank #5	15	10	0	10
15	24-Oct-12	German Bank #6	17	1	0	1
1	24-Sep-12	Little Hope #1	0	1	12	10
2	10-Oct-12	Little Hope #2	16	1	0	14
3	17-Oct-12	Mapping Boats Only	7	0	3	3
1	03-Oct-12	Eastern Shore #1	0	2	0	2
2	26-Oct-12	Eastern Shore #2	23	1	0	1
Total number of survey boat nights				104	17	121

Table 3A. Summary of 2011 fish sampled by survey date and location with TS estimate from samples, and TS estimate for a 28cm herring using the length/weight equation.

Date of Survey	Location of Survey	Interval (days)	Number of Length Samples	Number of Fish Measured	Number Len/Wt Fish	Mean Length (mm)	Mean Weight (g)	TS dB/kg	Wt 28cm Fish (g)	TS 28cm Fish dB/kg
25-May-11	Spec Buoy #1	0	0	0	0	280*	180	-35.960	180	-35.960
02-Jul-11	Scots Bay #1	0	12	2236	79	258	137	-35.049	179	-35.488
16-Jul-11	Scots Bay #2	14	8	1510	75	255	130	-34.928	174	-35.369
30-Jul-11	Scots Bay #3	14	16	3210	143	254	134	-35.075	185	-35.617
13-Aug-11	Scots Bay #4	13	18	3060	85	251	128	-34.961	180	-35.517
26-Aug-11	Scots Bay #5	13	9	1602	68	248	122	-34.875	181	-35.543
07-Aug-11	Trinity Ledge #1	0	1	85	85	261	142	-34.970	176	-34.970
31-Aug-11	Trinity Ledge #2	24	1	48	48	246	119	-35.166	175	-35.166
12-Sep-11	Trinity Ledge #3	12	1	87	87	266	154	-34.741	179	-34.741
26-Aug-11	German Bank #1 North	0	1	202	273	265	141	-34.914	168	-35.213
	German Bank #1 South		10	1864	273	221	78	-33.907	168	-35.213
08-Sep-11	German Bank #2	12	9	1793	117	266	147	-35.058	173	-35.334
21-Sep-11	German Bank #3	13	13	2643	218	262	139	-34.962	173	-35.327
10-Oct-11	German Bank #4	19	24	4513	88	258	124	-34.616	166	-35.154
23-Oct-11	German Bank #5	13	0	0	0	280*	180	-35.960	180	-35.960
21-Sep-11	Seal Island	0	13	2643	218	262	139	-34.962	173	-35.327
27-Sep-11	Little Hope #2b	4	1	75	75	267	144	-34.957	169	-34.957
07-Oct-11	Little Hope #3	10	0	0	0	280*	180	-35.960	180	-35.960
18-Oct-11	Little Hope #4	11	0	0	0	280*	180	-35.960	180	-35.960
28-Oct-11	Little Hope #6	5	1	22	22	291	197	-35.455	174	-35.455
22-Sep-11	Eastern Shore #1	0	1	198	37	289	182	-35.266	165	-35.266
03-Oct-11	Eastern Shore #2	11	1	29	29	299	205	-35.417	170	-35.417
08-Oct-11	Eastern Shore #3	5	1	32	32	311	232	-35.596	176	-35.596
15-Sep-11	Glace Bay #1	0	0	0	0	280*	180	-35.960	180	-35.960

* Standard length, weight, TS.

Note: For Seal Island, German Bank samples and TS were used.

Table 3B. Summary of 2012 fish sampled by survey date and location with TS estimate from samples, and TS estimate for a 28cm herring using the length/weight equation.

Date of Survey	Location of Survey	Interval (days)	Number of Length Samples	Number of Fish Measured	Number Len/Wt Fish	Mean Length (mm)	Mean Weight (g)	TS (dB/kg)	Wt 28cm Fish (g)	TS 28cm Fish (dB/kg)
30-Jun-12	Scots Bay #1	0	18	3024	60	270	163	-35.382	181	-35.539
14-Jul-12	Scots Bay #2	14	22	3637	332	270	157	-35.236	178	-35.456
28-Jul-12	Scots Bay #3	14	20	3566	155	267	157	-35.343	183	-35.590
11-Aug-12	Scots Bay #4	13	12	2097	48	264	146	-35.133	177	-35.434
25-Aug-12	Scots Bay #5	14	13	2122	147	262	144	-35.113	178	-35.452
07-Aug-12	Trinity Ledge #1	0	0	0	0	280*	180	-35.960	180	-35.960
23-Aug-12	Trinity Ledge #2	16	0	0	0	280*	180	-35.960	180	-35.960
03-Sep-12	Trinity Ledge #3	10	0	0	0	280*	180	-35.960	180	-35.960
12-Aug-12	German Bank #1	0	11	2080	80	270	152	-35.083	170	-35.254
26-Aug-12	German Bank #2	14	19	3504	235	267	144	-34.972	167	-35.193
09-Sep-12	German Bank #3	13	20	3572	28	265	145	-35.040	168	-35.201
22-Sep-12	German Bank #4	13	15	2666	82	261	137	-34.932	172	-35.310
07-Oct-12	German Bank #5	15	27	4760	102	262	130	-34.675	163	-35.066
24-Oct-12	German Bank #6	17	2	311	31	269	147	-34.988	168	-35.214
24-Sep-12	Little Hope #1	0	1	54	54	278	163	-35.024	166	-35.024
10-Oct-12	Little Hope #2	16	1	106	106	279	164	-35.028	166	-35.028
03-Oct-12	Eastern Shore #1	0	1	32	32	293	193	-35.316	166	-35.316
26-Oct-12	Eastern Shore #2	23	1	32	32	298	212	-35.570	175	-35.570

* Standard length, weight, TS.

Note: TS values used for 50kHz system when no sampling was available. Further adjustments also made for frequency of systems used.

Table 4A. Summary of the 2011 Scots Bay spawning ground acoustic survey data and associated biomass estimates for the standard survey box area (inbox) and for outside the survey box (outbox).

Location / Type	Date	TS (dB/kg)	Area (km^2)	Weighted Sa (dB/m^2)	Density (kg/m^2)	Biomass (tons)	SE (tons)	SE (%)
Scots Bay (inbox)	02-Jul-11	-35.13	626	-50.15	0.031	19,712	7,611	39
	16-Jul-11	-35.12	626	-48.18	0.049	30,883	12,310	40
	30-Jul-11	-35.11	626	-47.89	0.053	32,956	18,114	55
	13-Aug-11	-35.09	626	-51.32	0.024	14,928	4,825	32
	26-Aug-11	-35.07	626	-54.50	0.011	7,135	3,522	49
Scots Bay total for standard survey area (inbox)						105,613	22,701	21
Scots Bay (outbox)	02-Jul-11	-35.13	297	-47.29	0.061	17,994	9,710	54
	16-Jul-11	-35.12	312	-51.14	0.025	7,717	12,450	2
	30-Jul-11	-35.25	284	-57.68	0.006	1,620	769	47
	13-Aug-11	-35.05	295	-56.82	0.007	1,970	773	47
	26-Aug-11	-35.05	299	-52.19	0.019	5,798	5,343	92
Scots Bay total for non-standard survey area (outbox)						35,099	16,704	48
Scots Bay overall total all survey areas						140,712	28,185	20

Note 1: Sept. 25 survey data not included as was a scout boat with no fish reported.

Table 4B. Summary of the 2012 Scots Bay spawning ground acoustic survey data and associated biomass estimates for the standard survey box area (inbox) and for outside the survey box (outbox)

Location / Type	Date	TS (dB/kg)	Area (km^2)	Weighted Sa (dB/m^2)	Density (kg/m^2)	Biomass (tons)	SE (tons)	SE (%)
Scots Bay (inbox)	30-Jun-12	-35.50	626	-47.47	0.063	39,748	4,170	10
	14-Jul-12	-35.34	626	-47.13	0.066	41,448	9,076	22
	28-Jul-12	-35.42	626	-48.25	0.052	32,636	21,050	64
	11-Aug-12	-35.34	626	-50.22	0.033	20,369	7,511	37
	25-Aug-12	-35.21	626	-53.47	0.015	9,348	2,589	28
Scots Bay total for standard survey area (inbox)						143,550	24,617	17
Scots Bay (outbox)	30-Jun-12	-35.51	214.00	-46.96	0.094	20047	9497	47
	14-Jul-12	-35.39	192.00	-46.60	0.075	14339	3450	24
	28-Jul-12	-35.51	117.00	-48.41	0.052	6120	1431	23
	11-Aug-12	-35.20	77.00	-56.47	0.007	570	45	8
	25-Aug-12	-35.18	44.00	-58.56	0.005	202	52	26
Scots Bay total for non-standard survey area (outbox)						41,279	10,206	25
Scots Bay overall total all survey areas						184,828	26,648	14

Table 5A. Summary of the 2011 German Bank spawning ground acoustic survey results and SSB biomass estimates for the standard survey box area (inbox) and for outside the survey box (outbox). The shaded row (Oct. 23 inbox) represent survey data, which were not included in the overall totals as there were no samples available.

Location / Type	Date	TS (dB/kg)	Area (km^2)	Weighted Sa (dB/m^2)	Density (kg/m^2)	Biomass (tons)	SE (tons)	SE (%)
German Bank (inbox)	26-Aug-11	-34.55	646	-47.31	0.054	27,414	12,326	35
	08-Sep-11	-35.09	646	-42.74	0.172	111,164	51,699	47
	21-Sep-11	-35.01	646	-41.58	0.221	142,509	84,329	59
	10-Oct-11	-34.79	640	-53.47	0.014	7,889	4,522	52
(not included in total)	23-Oct-11	-35.54	260	-52.39	0.021	5,368	2,289	43
German Bank inbox total (not including Oct. 23)						288,976	53,340	18
German Bank (outbox)	26-Aug-11	-34.01	224	-52.76	0.013	2,991	3,009	101
	08-Sep-11	-35.17	204	-50.98	0.026	5,344	2,828	53
	21-Sep-11	-35.16	130	-54.75	0.011	1,428	693	49
	10-Oct-11	-34.72	222	-55.41	0.009	1,722	1,794	95
German Bank outbox total						11,485	3,009	26
German Bank overall (not including Oct. 23)						300,461	53,425	18

Table 5B. Summary of the 2012 German Bank spawning ground acoustic survey results and SSB biomass estimates for the standard survey box area (inbox) and for outside the survey box (outbox).

Location / Type	Date	TS (dB/kg)	Area (km^2)	Weighted Sa (dB/m^2)	Density (kg/m^2)	Biomass (tons)	SE (tons)	SE (%)
German Bank (inbox)	12-Aug-12	-35.21	646	-48.26	0.050	32,025	7,221	23
	26-Aug-12	-35.07	646	-43.07	0.159	102,488	23,508	23
	09-Sep-12	-35.16	646	-45.57	0.091	58,699	24,501	42
	22-Sep-12	-35.01	646	-45.41	0.091	58,933	24,968	42
	07-Oct-12	-34.80	646	-49.92	0.031	19,848	8,229	41
(one school surveyed)	24-Oct-12	-34.99	0.38	-22.79	16.587	6,303	804	13
German Bank inbox total (not including Sept. 8, Sept. 23, Oct. 26)						278,296	43,553	16
German Bank (outbox)	12-Aug-12	-35.18	181	-55.95	0.008	1,516	340	22
	26-Aug-12	-35.13	198	-50.69	0.028	5,506	2,835	51
	09-Sep-12	-35.19	134	-55.61	0.009	1,217	331	27
	22-Sep-12	-35.15	66	-58.87	0.004	280	125	45
	07-Oct-12	-34.87	166	-54.95	0.010	1,627	917	56
German Bank outbox total						10,147	3,020	30
German Bank overall						288,443	43,657	15

Table 6. Catch dates, catch, and acoustic survey biomass for the Spectacle Buoy and Trinity Ledge herring fishery from 1998-2012. Survey biomass calculated with CIF. 'n/s' indicates no survey and '-' (dash) indicates data cannot be calculated.

	Spectacle Buoy Catches and Surveys				Trinity Ledge Catches and Surveys				
Year	Start Day	End Day	Catch (tons)	Survey SSB (tons)*	Start Day	End Day	Catch (tons)	Survey SSB (tons)*	Exploitation Catch/SSB (%)
1998	10-May-98	30-Jun-98	484	n/s	24-Aug-98	21-Sep-98	1,668	n/s	-
1999	10-May-99	16-Jul-99	355	n/s	12-Aug-99	15-Sep-99	1,257	3,885	32
2000	11-Jun-00	14-Jun-00	80	n/s	30-Aug-00	12-Sep-00	734	621	118
2001	11-Jun-01	10-Jul-01	699	1,110	21-Aug-01	26-Sep-01	1,012	14,797	7
2002	15-May-02	01-Jul-02	137	n/s	02-Sep-02	30-Sep-02	256	8,096	3
2003	04-Jun-03	06-Jun-03	69	1,420	21-Aug-03	18-Sep-03	369	12,117	3
2004	17-Jun-04	15-Jul-04	5	n/s	02-Sep-04	15-Sep-04	225	12,022	2
2005	09-Jun-05	11-Jul-05	124	290	05-Sep-05	20-Sep-05	447	10,701	4
2006	03-Jun-06	22-Jun-06	2	n/s	23-Aug-06	21-Sep-06	717	16,076	4
2007	07-May-07	22-Jun-07	243	310	27-Aug-07	20-Sep-07	1,091	3,113	35
2008	29-May-08	19-Jun-08	6	0	21-Aug-08	25-Sep-08	7	516	1
2009	11-Jun-09	25-Jun-09	0.2	n/s	01-Sep-09	11-Sep-09	116	1,575	7
2010	02-Jun-10	19-Jun-10	-	1,859	11-Aug-10	24-Sep-10	202	2,405	8
2011	22-Jun-11	29-Jun-11	1	282	09-Aug-11	20-Sep-11	638	7,316	9
2012	31-May-12	31-May-12	-	n/s	15-Aug-12	18-Sep-12	448	2,754	16
Average			147	753	-		612	6,857	-

* Survey SSB calculated with CIF after 2003 inclusive.

Table 7. Biomass estimation for the 2011 Spectacle Buoy area acoustic surveys. Survey biomass was calculated with CIF. No surveys were conducted in 2012 in the area.

Location / Type	Date	Mean Length (mm)	TS (dB/kg)	Area (km^2)	Weighted Sa (dB/m^2)	Density (kg/m^2)	Biomass (tons)	SE (tons)	SE %
Spec Buoy #1	25-May-11	28	-36.0	0.3	-35.6	1.084	282	174	62
Spectacle Buoy total for 2011							282	174	62

Table 8A. Biomass estimation for the 2011 Trinity Ledge acoustic surveys. Survey biomass was calculated with CIF.

Location / Type	Date	Mean Length (mm)	TS (dB/kg)	Area (km^2)	Weighted Sa (dB/m^2)	Density (kg/m^2)	Biomass (tons)	SE (tons)	SE (%)
Trinity Ledge #1	07-Aug-11	26	-35.5	0.4	-31.9	2.283	982	178	18
Trinity Ledge #2	31-Aug-11	27	-35.8	1.1	-31.2	2.801	3,194	624	0
Trinity Ledge #3	12-Sep-11	25	-35.3	0.9	-29.8	3.568	3,140	451	14
Trinity Ledge total for 2011							7,315	485	7

Table 8B. Biomass estimation for the 2012 Trinity Ledge acoustic surveys. Survey biomass was calculated with CIF.

Location / Type	Date	Mean Length (mm)	TS (dB/kg)	Area (km^2)	Weighted Sa (dB/m^2)	Density (kg/m^2)	Biomass (tons)	SE (tons)	SE (%)
Trinity Ledge #1	07-Aug-12	28	-36.0	25.8	-62.8	0.002	53	67	126
Trinity Ledge #2	23-Aug-12	28	-36.0	1.4	-37.8	0.653	894	242	27
Trinity Ledge #3	03-Sep-12	28	-36.0	0.2	-26.8	8.215	1,807	214	12
Trinity Ledge total for 2012							2,754	330	12

Table 9. Summary of the minimum observed SSB for each of the surveyed spawning grounds in the Bay of Fundy/SWNS component of the 4WX stock complex. Total SSB rounded to nearest 100t and all data calculated with the CIF. 'n/s' indicates no survey and '-' (dash) indicates no data for that category.

Location/Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Average 2005-2010	Average 1999-2012
Scots Bay (inbox)	45,909	185,498	216,000	129,300	123,000	115,000	21,200	31,600	50,500	23,300	81,600	42,300	105,600	143,500	41,750	93,879
Scots Bay (outbox)	-	-	-	-	-	-	-	-	2,200	100	6,100	11,700	35,100	41,300	11,040	16,083
Scots Bay total	45,909	185,498	216,000	129,300	123,000	115,000	21,200	31,600	52,700	23,400	87,700	54,000	140,700	184,800	45,100	100,772
German Bank (inbox)	495,360	333,940	257,300	416,200	348,800	392,000	268,600	290,500	495,400	238,600	395,900	234,700	289,000	278,300	320,617	338,186
German Bank (outbox)	-	-	-	-	-	-	-	4,900	4,000	2,400	1,700	19,100	11,500	10,100	6,420	7,671
German Bank total	495,360	333,940	257,300	416,200	348,800	392,000	268,600	295,400	499,400	241,000	397,600	253,800	300,500	288,400	325,967	342,021
Trinity Ledge	4,061	1,336	14,800	8,900	12,100	12,000	10,700	16,100	3,100	500	1,600	2,400	7,300	2,800	5,733	6,978
Spec Buoy (spring)	-	-	1,100	-	1,200	n/s	600	n/s	300	0	-	1,900	300	n/s	700	771
Spec Buoy (fall)	-	-	87,500	-	-	-	-	30	-	-	-	-	-	-	30	43,765
Overall Stock Area	545,330	520,774	576,700	554,400	485,100	519,000	301,100	343,130	555,500	264,900	486,900	312,100	448,800	476,000	377,272	456,410
Seal Island	-	-	3,900	1,200	11,900	-	-	10,000	-	-	-	-	1,500	-	10,000	5,700
Browns Bank	-	-	45,100	-	-	-	-	7,700	-	-	-	-	-	-	7,700	26,400
Total All Areas	545,330	520,774	625,700	555,600	497,000	519,000	301,100	360,830	555,500	264,900	486,900	312,100	450,300	476,000	380,222	462,217
OVERALL SE (tons)	89,024	70,347	30,539	65,978	86,276	79,366	82,593	57,484	132,719	38,284	94,294	39,863	60,406	44,705	-	69,420
OVERALL SE (%)	16	14	5	12	17	15	27	16	24	14	19	13	13	9	-	15

Table 10A. The 2011 herring acoustic surveys for Little Hope/Port Mouton with survey biomass and final total for the area (calculated with CIF).

Location/Date	TS (dB/kg)	Area (km^2)	Weighted Sa (dB/m^2)	Biomass Density (kg/m^2)	Biomass (tons)	SE (tons)	SE (%)
Little Hope #1 - Sept. 17	-36.96	1.2	-45.20	0.119	143	59	41
Little Hope #2a - Sept. 23	-35.96	0.5	-35.09	1.223	636	353	56
Little Hope #2b - Sept. 27	-35.69	6.8	-38.89	0.479	3,250	425	13
Little hope #3 - Oct. 7	-35.96	11.0	-35.32	1.159	12,748	2,364	19
Little Hope #4 - Oct. 18	-35.96	9.6	-36.25	0.935	8,995	1,323	15%
Little Hope #5 - Oct. 23	-35.96	1.4	-28.59	5.458	7,641	2,034	27
Little Hope #6 - Oct. 28	-36.05	7.7	-39.12	0.493	3,803	938	25
Initial All Surveys	-36.08	30.5	-35.69	1.095	37,216	2,743	7
Final 2011 Surveys (see note)	-35.92	27.2	-35.99	0.983	28,796	3,329	12

Note: Exclude Sept. 17 (poor survey, little fish), Sept. 23 (fishing night, poor survey), and Oct. 23 (same area and fish as Oct. 18).

Table 10B. The 2012 herring acoustic surveys for Little Hope/Port Mouton with survey biomass and final total for the area (calculated with CIF).

Location/Date	TS (dB/kg)	Area (km^2)	Weighted Sa (dB/m^2)	Biomass Density (kg/m^2)	Biomass (tons)	SE (tons)	SE (%)
Little Hope #1V - Sept. 24	-35.58	2.0	-30.53	3.199	6445	4599	0.71
Little Hope #1H - Sept. 24	-35.58	1.1	-26.59	7.930	8997	4489	0.50
Little Hope #1 – Sept. 24	-35.58	1.0	-30.88	2.991	3083	2139	0.69
Little Hope #2 - Oct. 10	-35.59	3.6	-42.85	0.188	676	109	0.16
Initial All Surveys	-35.58	7.8	-31.66	2.466	19,201	6,774	35%
Final 2012 Surveys (see note)	-35.58	7.8	-31.66	2.466	12,756	6,774	35%

Note: 1H and 1V is the same school - higher biomass accepted; Oct. 17 mapping boats data not processed

Table 11A. The 2011 Halifax/Eastern Shore herring acoustic survey results with survey biomass and final total for the area (calculated with CIF).

Location/Date	TS (dB/kg)	Area (km²)	Weighted Sa (dB/m²)	Biomass Density (kg/m²)	Biomass (tons)	SE (tons)	SE (%)
Eastern Shore #1 - Sept. 22	-35.72	1.7	-33.94	1.504	2,541	648	0.25
Eastern Shore #2 - Oct. 3	-35.93	1.4	-47.00	0.078	112	46	0.41
Eastern Shore #3 – Oct. 8	-36.15	5.1	-38.72	0.554	2,845	496	0.17
Initial All Surveys	-35.93	8.3	-37.70	0.666	5,498	818	15%
Final All Surveys (see note)	-36.44	5.2	-28.67	5.339	5,498	3,461	13%

Note: Excludes Oct. 19 camera survey Owls Head.

Table 11B. The 2012 Halifax/Eastern Shore herring acoustic survey results with survey biomass and final total for the area (calculated with CIF).

Location/Date	TS (dB/kg)	Area (km²)	Weighted Sa (dB/m²)	Biomass Density (kg/m²)	Biomass (tons)	SE (tons)	SE (%)
Eastern Shore #1 - Oct. 3	-35.87	1.05	-34.20	1.471	1,544	330	21
Eastern Shore #2 - Oct. 26	-36.13	0.32	-27.91	6.637	2,124	707	33
Initial All Surveys	-36.00	1.4	-31.72	2.678	3,668	780	21%
Final All Surveys	-36.00	1.4	-31.72	2.678	3,668	780	21%

Table 12. The 2000-2012 Lunenburg Box area (Liverpool to Chebucto Head for statistical districts 22-26) catch and effort with start and end dates, total catch, number of sets, number of days with landings and number of active vessels with landings in these districts. Note set data available from 2006 onwards only; from 2000-2005 (shaded cells) only catch by day available.

YEAR	MIN. DAY	MAX. DAY	DAY RANGE	CATCH	NO. SETS	NO. DAYS	NO. VESSELS
2000	01-May-00	14-Oct-00	167	27	46	34	11
2001	18-May-01	13-Oct-01	149	21	54	37	10
2002	05-May-02	12-Oct-02	161	29	84	48	15
2003	07-Jun-03	21-Oct-03	137	48	44	33	12
2004	13-Jun-04	30-Nov-04	171	32	34	22	12
2005	30-Jun-05	31-Oct-05	124	140	58	20	11
2006	03-May-06	30-Nov-06	212	64	134	53	18
2007	23-Jun-07	26-Nov-07	157	21	72	42	13
2008	04-May-08	06-Nov-08	187	47	106	44	14
2009	23-May-09	30-Nov-09	192	182	121	40	15
2010	30-Apr-10	12-Oct-10	166	164	80	31	15
2011	31-May-11	31-Oct-11	154	142	94	25	16
2012	24-May-12	31-Oct-12	161	34	52	22	9
Average			164	73	75	35	13

Table 13. The 2011 herring acoustic surveys for Glace Bay (using standard TS with CIF; no samples available). There were no surveys in 2012.

Location / Type	Date	Mean Length (mm)	TS (dB/kg)	Area (km^2)	Weighted Sa (dB/m^2)	Biomass Density (kg/m^2)	Biomass (tons)	SE (tons)	SE (%)
Glace Bay #1	15-Sep-11	28	-36.0	38.7	-64.7	0.0013	51	46	89
Initial All Surveys			-36.0	38.7	-64.7	0.0013	51	46	89
Final All Surveys (see notes)			-36.0	38.7	-64.7	0.0013	51	46	89

Note: No proper surveys were conducted on Sept. 22, Sept. 29, Oct. 9 or Oct. 22.

Table 14A. Landings (tons) by spawning area for coastal Nova Scotia from 1996-2012, with last 5-year (shaded green) and overall averages. 'n/a' indicates not applicable.

Location		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Average Catch Last 5 yr.	Average Catch All Years
Little Hope/Port Mouton	Catch	n/a	490	1,170	2,919	2,043	2,904	3,982	4,526	1,267	2,239	3,133	1,506	1,108	3,731	3,106	2,564	2,150	2,532	2,427
	Allocation	n/a	n/a	n/a	n/a	1,495	1,170	1,410	2,248	3,028	3,162	3,952	4,008	2,944	2,172	2,454	2,094	2,188	n/a	n/a
Halifax/Eastern Shore	Catch	1,280	1,520	1,100	1,628	1,350	1,898	3,334	2,727	4,176	3,446	3,348	3,727	2,381	6,045	2,456	1,040	799	2,544	2,486
	Allocation	n/a	n/a	n/a	n/a	1,425	1,313	1,403	1,952	3,638	3,802	4,323	5,367	5,103	3,857	4,373	4,188	2,920	n/a	n/a
Glace Bay	Catch	n/a	170	1,730	1,040	834	1,204	3,058	1,905	1,481	626	85	45	12	4	11	0	7	7	763
Bras d'Or Lakes	Catch	170	160	120	31	56	0	1	4	0	0	0	0	0	0	0	0	0	0	32
	Total	1,450	2,340	4,120	5,618	7,203	8,489	13,187	13,362	13,590	13,275	14,841	14,653	11,547	15,809	12,400	9,886	8,064	11,541	9,990

Table 14B. Acoustic survey SSB (tons) by spawning area for coastal Nova Scotia from 1998-2012, with last 5-year (shaded green) and overall averages (with CIF). Note that no surveys were conducted prior to 1998. 'n/s' indicates no survey. Data shaded yellow without CIF.

Location	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	SSB Average Last 5 yrs.	SSB Average All years
Little Hope/Port Mouton	14,100	15,800	5,200	21,300	56,000	**53,100**	22,500	44,700	24,100	2,800	14,500	36,600	26,700	28,796	12,756	23,870	25,263
Halifax/Eastern Shore	8,300	20,200	10,900	16,700	41,500	92,600	28,400	36,950	68,900	28,300	30,300	54,200	27,700	5,498	3,668	24,273	31,608
Glace Bay	n/s	2,000	n/s	21,200	7,700	31,500	n/s	3,180	n/s	240	500	100	8	51	n/s	165	6,648
Bras d'Or Lakes	n/s	530	70	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	300

Table 14(C). Exploitation estimates (%) for coastal Nova Scotia spawning components from 1998-2012, with last 5-year and overall averages (with CIF). Exploitation estimates for Bras d'Or Lakes are not available. 'n/a' indicates not applicable. Data shaded yellow without CIF.

Location	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Average Last 5 yrs.	Average All Years
Little Hope/Port Mouton	8%	18%	39%	14%	7%	**9%**	6%	5%	13%	54%	8%	10%	12%	9%	17%	11%	15%
Halifax/Eastern Shore	13%	8%	12%	11%	8%	3%	15%	9%	5%	13%	8%	11%	9%	19%	22%	14%	11%
Glace Bay	n/a	52%	n/a	6%	40%	6%	n/a	20%	n/a	19%	2%	4%	n/a	n/a	n/a	3%	18%

Note cells shaded grey includes mapping surveys which estimated biomass based on visual sounder estimates; bold cells include mapping and acoustic surveys. Also, data prior to 2003 calculated with the CIF are not available and estimates of exploitation were not made for these years.

FIGURES

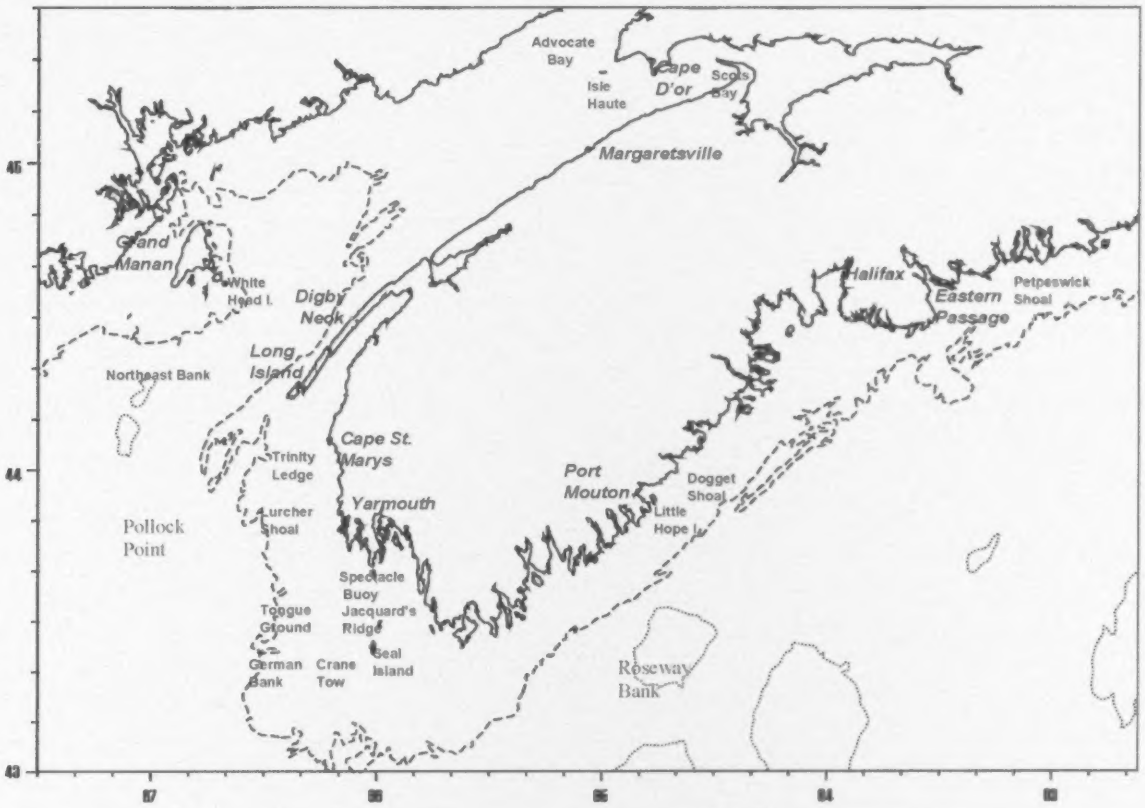

Figure 1. Map of the major spawning areas within the NAFO divisions 4WX herring stock complex.

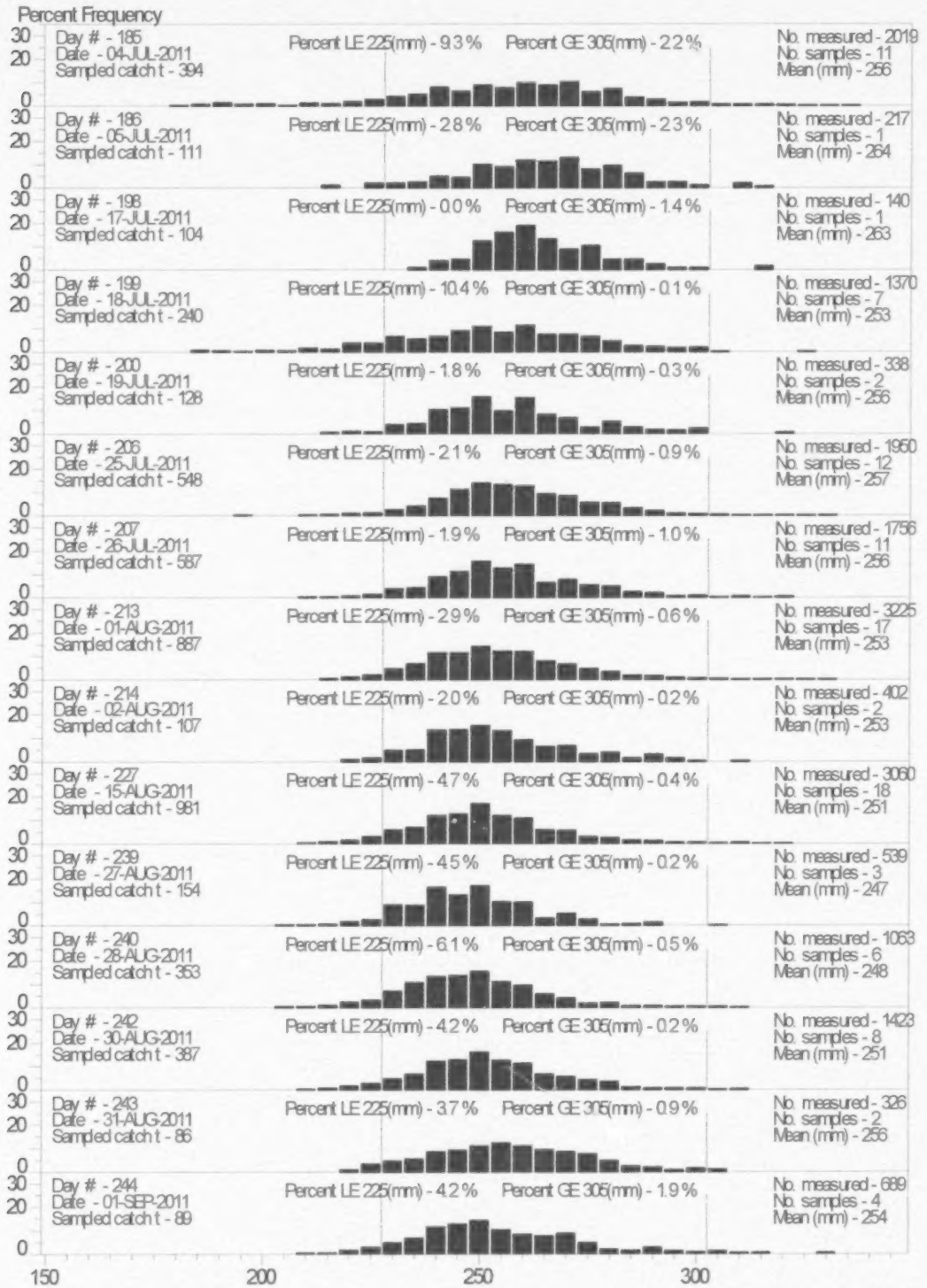

Figure 2A. Scots Bay daily herring length frequency samples collected from all landings in 2011, with proportions <=225mm and >=305mm. Length scale in millimeters with measurements grouped by ½cm.

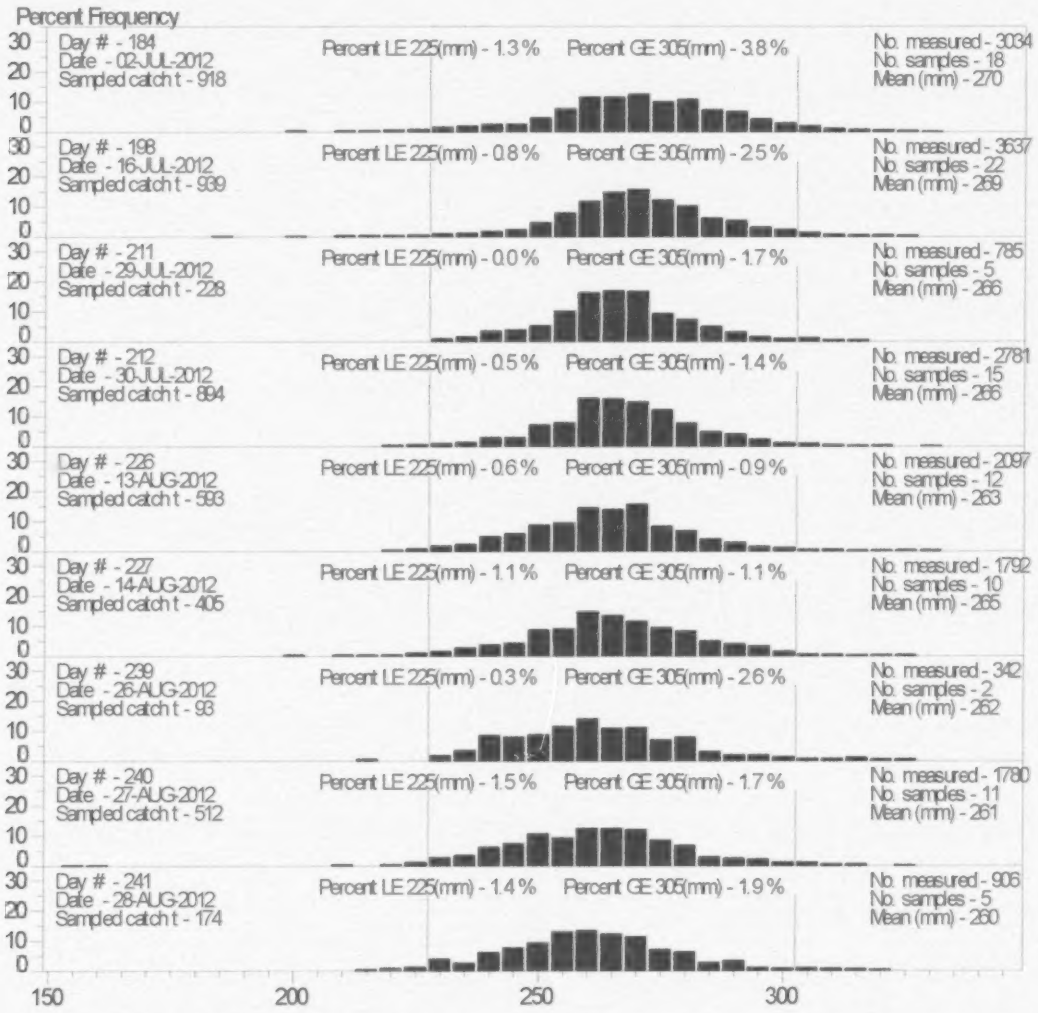

Figure 2B. Scots Bay daily herring length frequency samples collected from all landings in 2012, with proportions <=225mm and >=305mm. Length scale in millimeters with measurements grouped by ½cm.

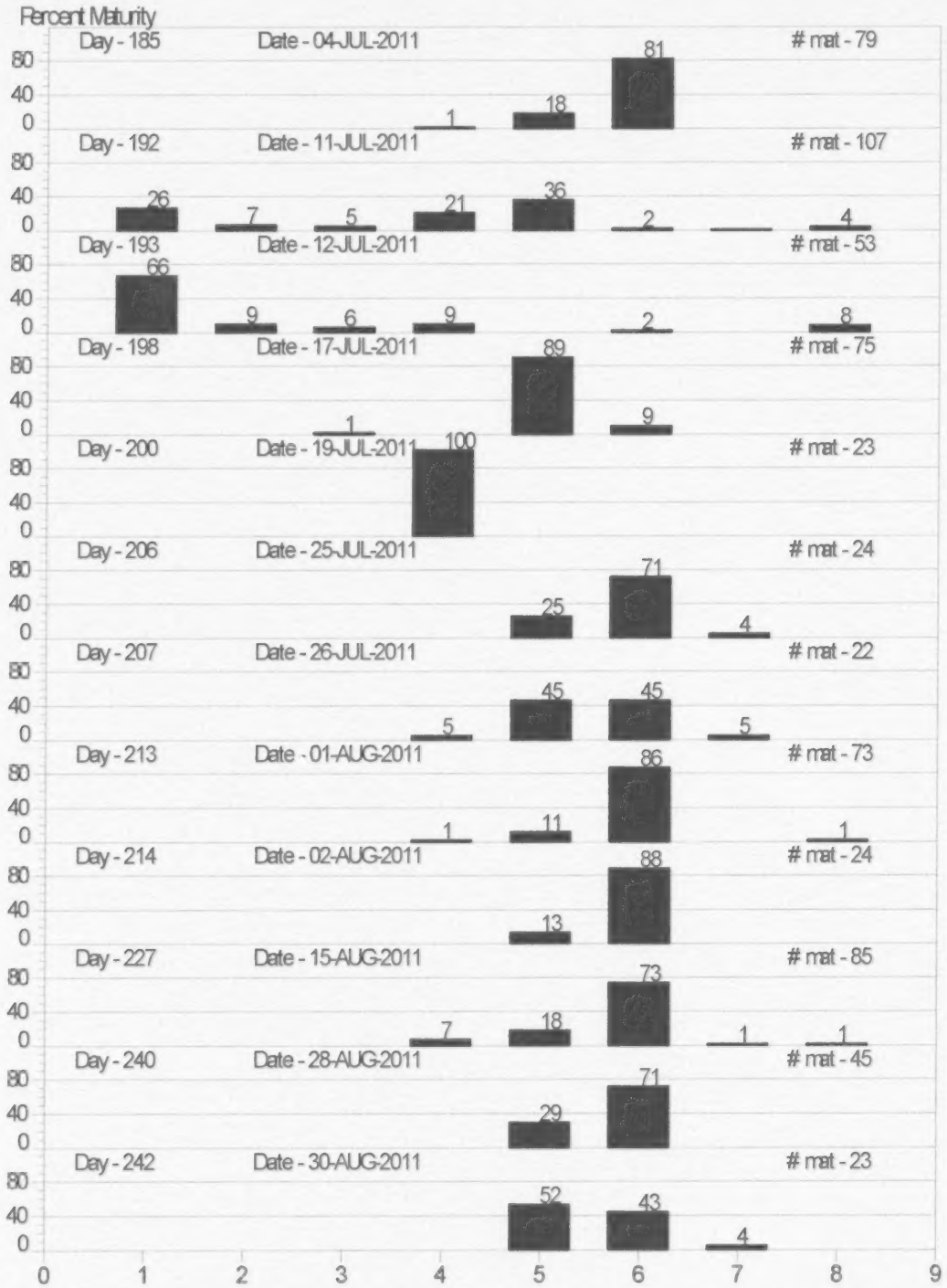

Figure 3A. Daily herring maturity samples collected from Scots Bay landings in 2011. (Staging codes 1-2=immature; 3-4-5=maturing/hard; 6=ripe and running; 7=spent; 8=recovering).

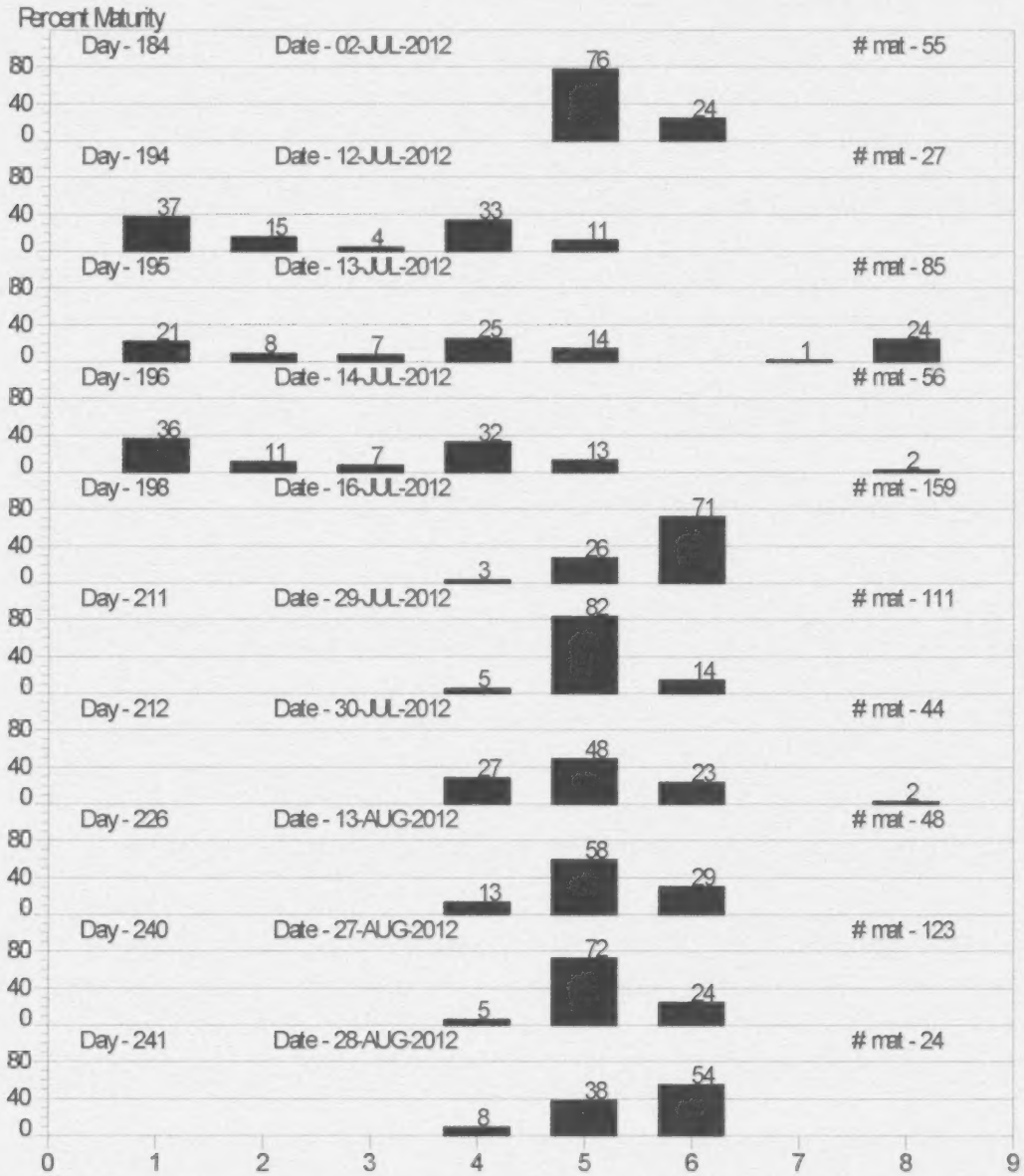

Figure 3B. Daily herring maturity samples collected from Scots Bay landings in 2012. (Staging codes 1-2=immature; 3-4-5=maturing/hard; 6=ripe and running; 7=spent; 8=recovering).

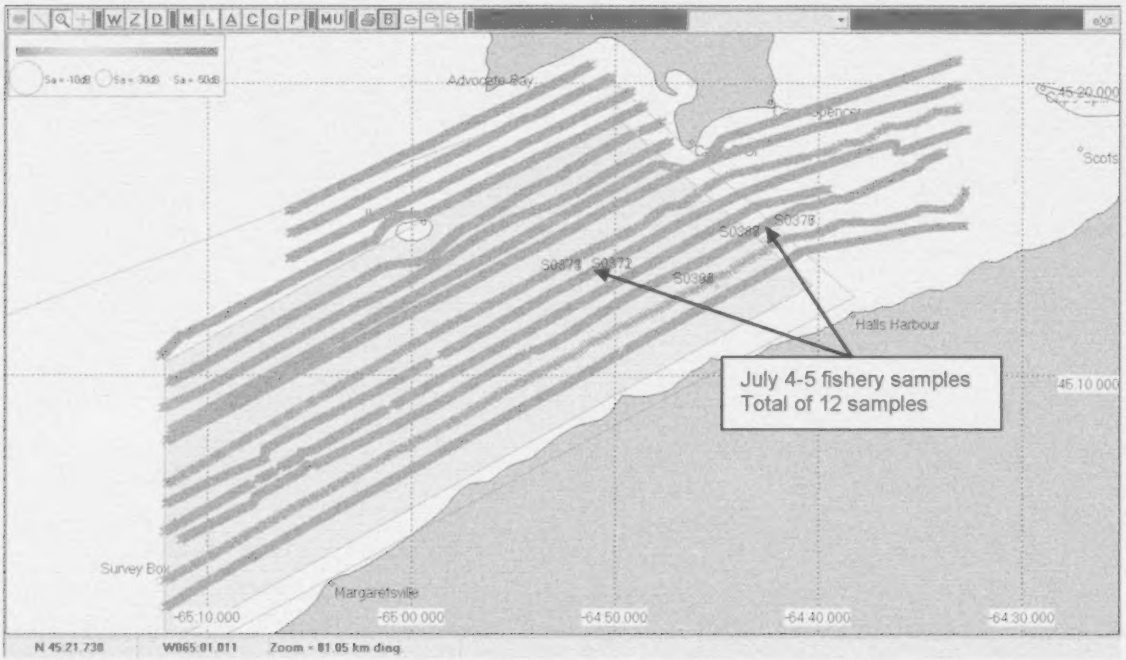

Figure 4A. Scots Bay acoustic survey (#1) on July 2, 2011, showing transects with backscatter (Sa) inside and outside the standard survey area along with locations of fishery samples.

Figure 4B. Scots Bay acoustic survey (#1) on June 30, 2012, showing transects with backscatter (Sa) inside and outside the standard survey area along with locations of fishery samples.

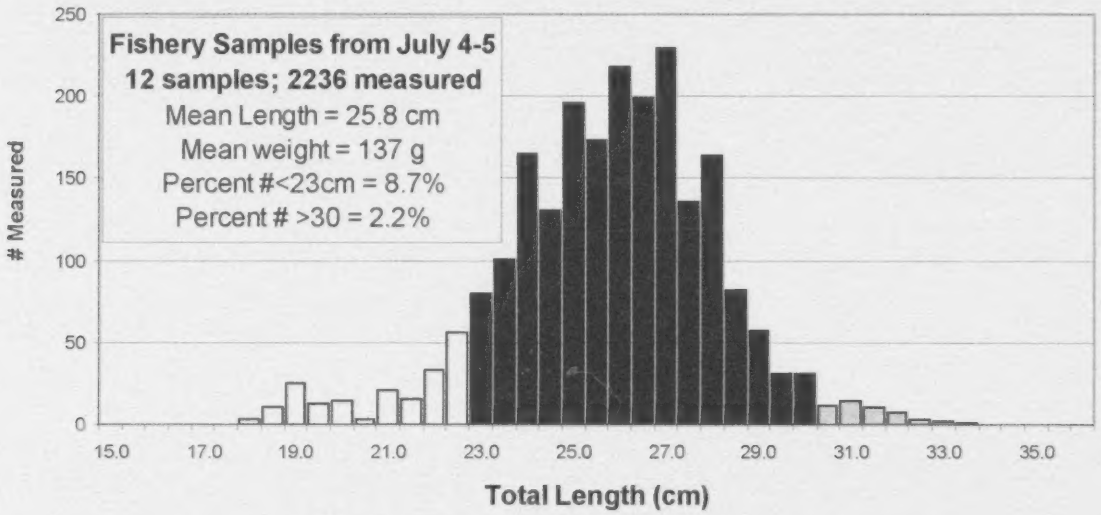

Figure 5A. Length distribution used for calculation of TS for the Scots Bay acoustic survey (#1) on July 2, 2011, from sampling on July 4-5, with proportions <23cm and >30cm shown as white and grey bars.

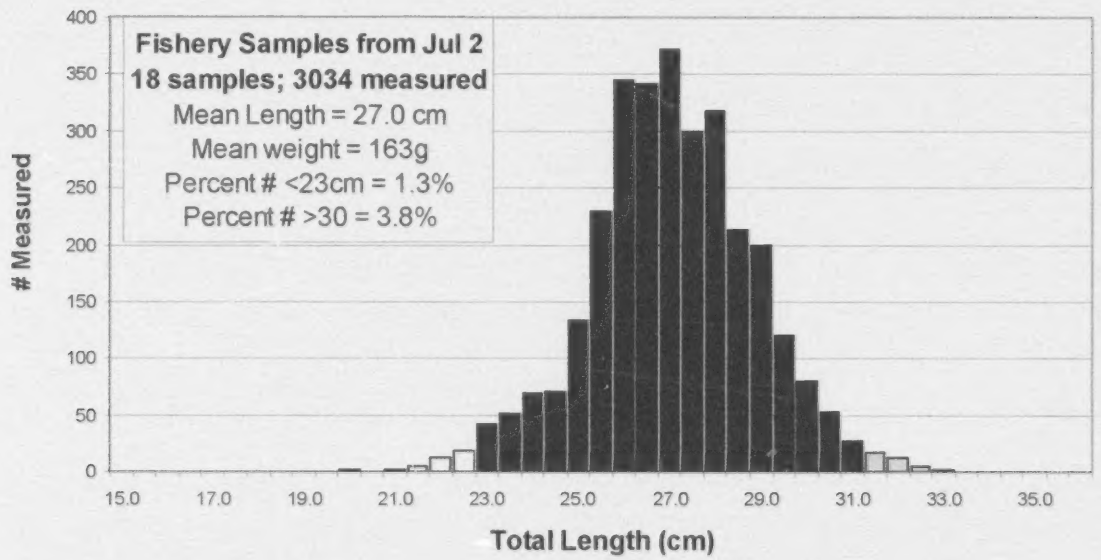

Figure 5B. Length distribution used for calculation of TS for the Scots Bay acoustic survey (#1) on June 30, 2012, from sampling on July 2, with proportions <23cm and >30cm shown as white and grey bars.

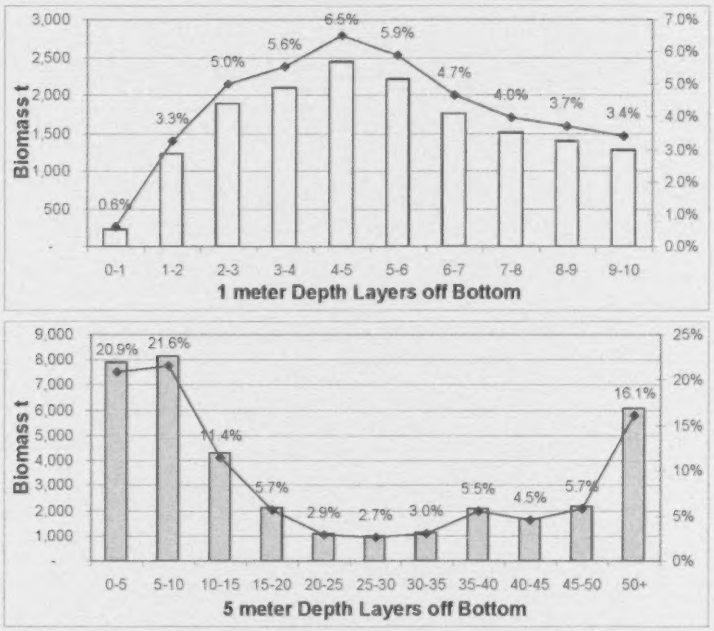

Figure 6A. Distribution of biomass by depth layer from bottom for the 2011 Scots Bay acoustic survey (#1) on July 2, 2011. Biomass is shown as histogram bars and percent as a line for total biomass by 1m layers from 0m to 9m (top panel) and by 5m layers from bottom to surface (bottom panel).

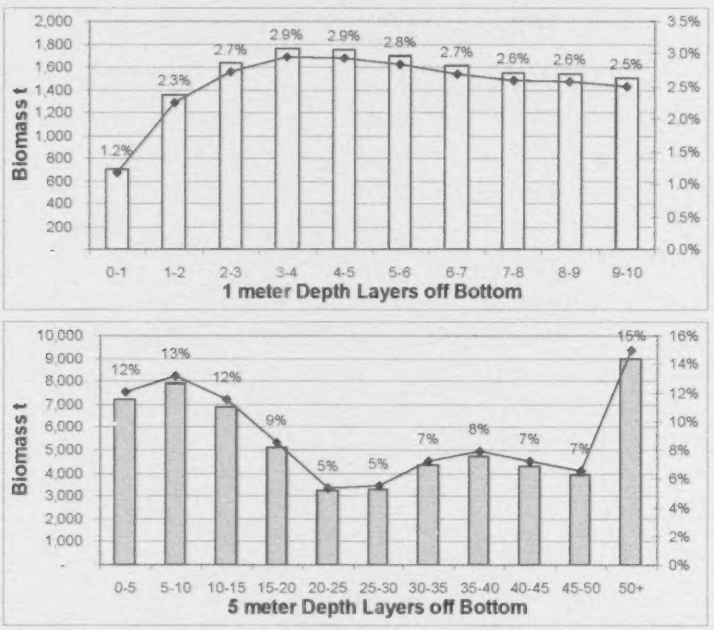

Figure 6B. Distribution of biomass by depth layer from bottom for the 2012 Scots Bay acoustic survey (#1) on June 30, 2012. Biomass is shown as histogram bars and percent as a line for total biomass by 1m layers from 0m to 9m (top panel) and by 5m layers from bottom to surface (bottom panel).

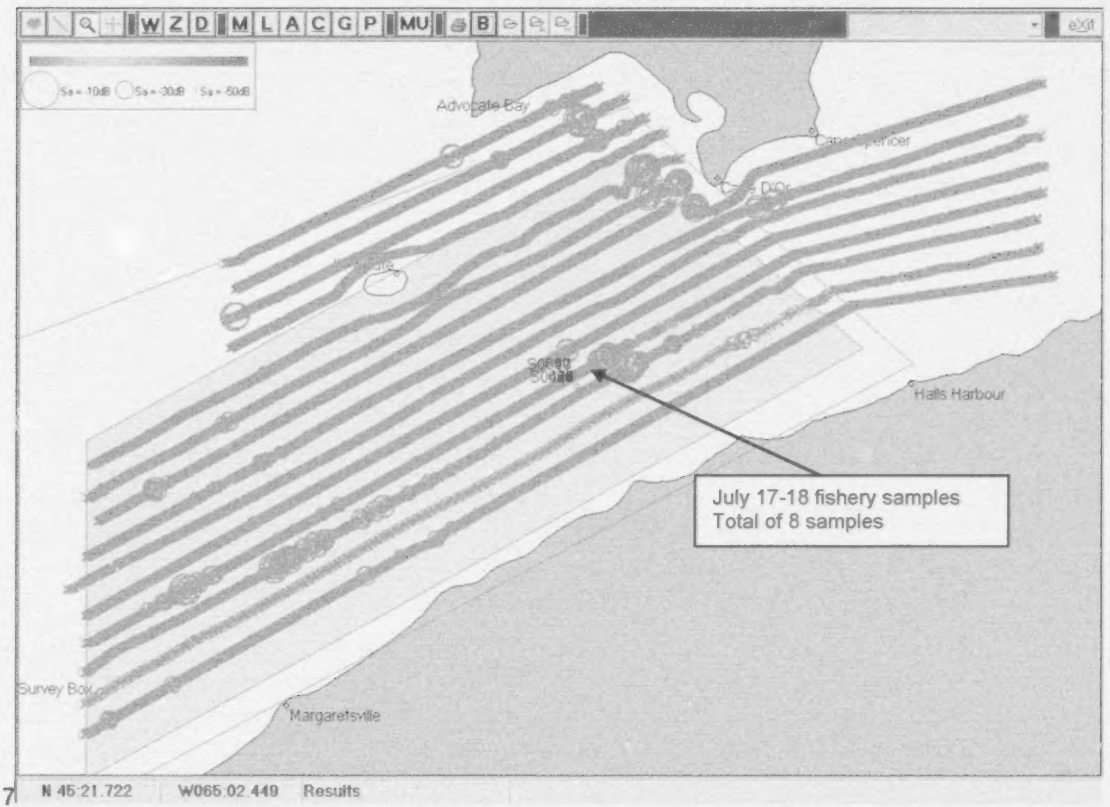

Figure 7A. Scots Bay acoustic survey (#2) on July 16, 2011, showing the main survey box (highlighted area) and transects with backscatter (Sa) along with locations for fishery samples.

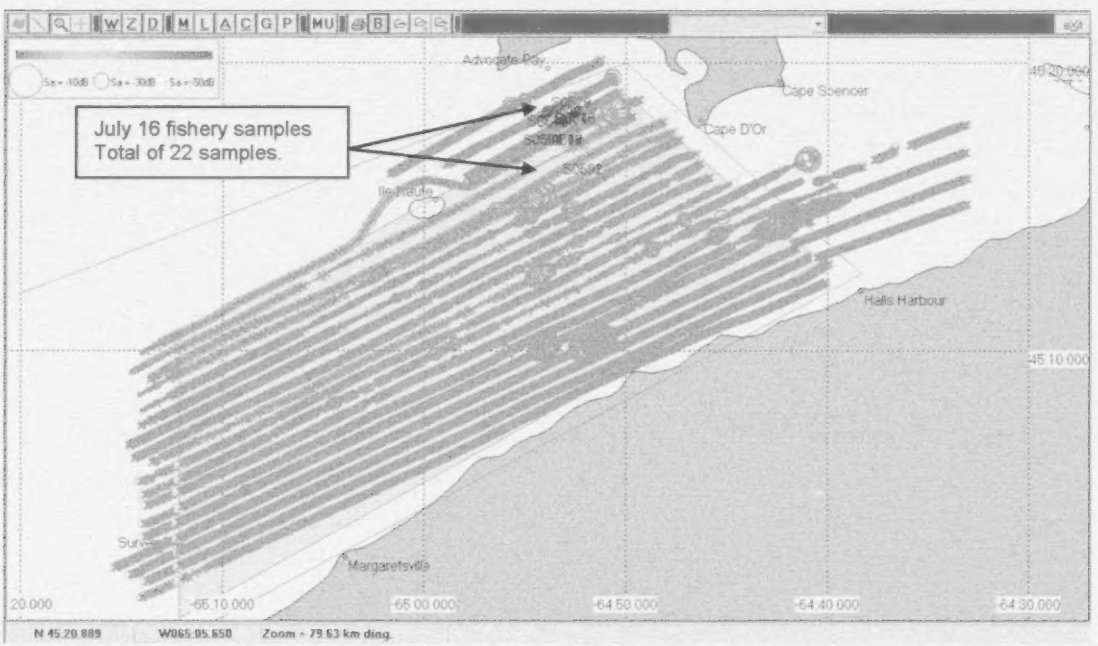

Figure 7B. Scots Bay acoustic survey (#2) on July 14, 2012, showing the main survey box (highlighted area) and transects with backscatter (Sa) along with locations for fishery samples.

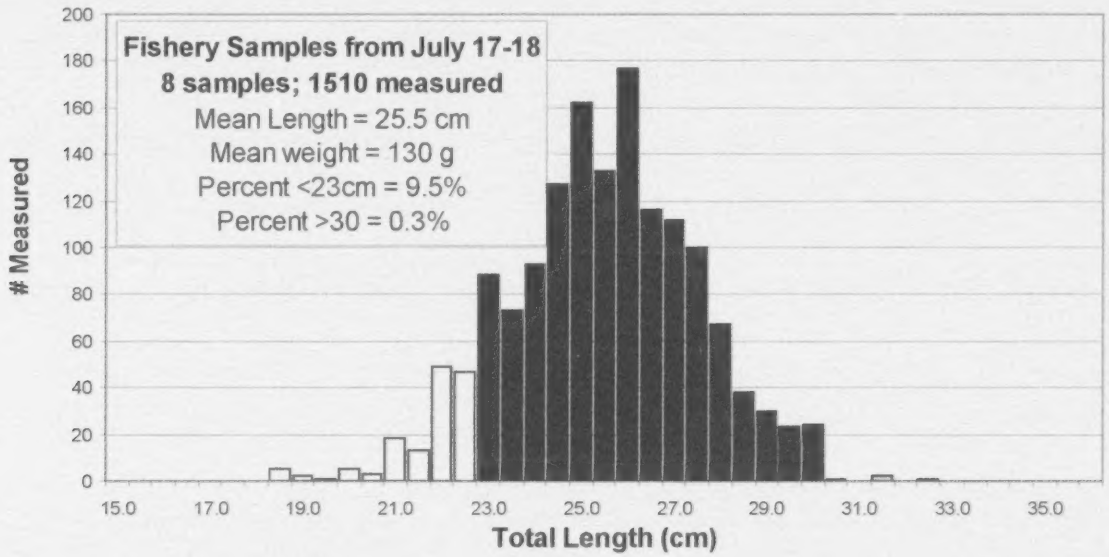

Figure 8A. Length distribution used for calculation of TS for the Scots Bay acoustic survey (#2) on July 16, 2011, from sampling on July 17-18, with proportions <23cm and >30cm shown as white and grey bars.

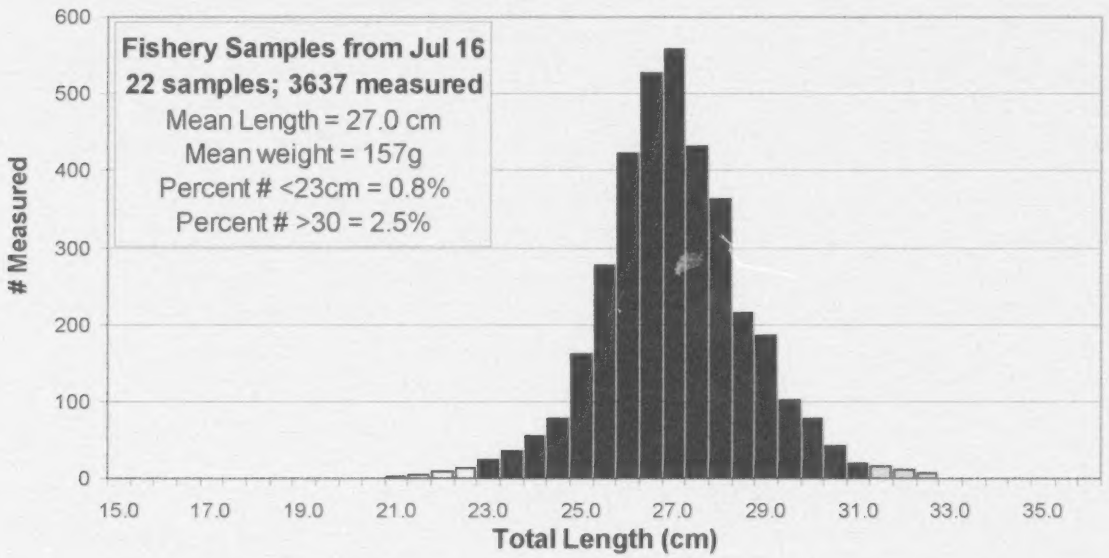

Figure 8B. Length distribution used for calculation of TS for the Scots Bay acoustic survey (#2) on July 14, 2012, from sampling on July 16, with proportions <23cm and >30cm shown as white and grey bars.

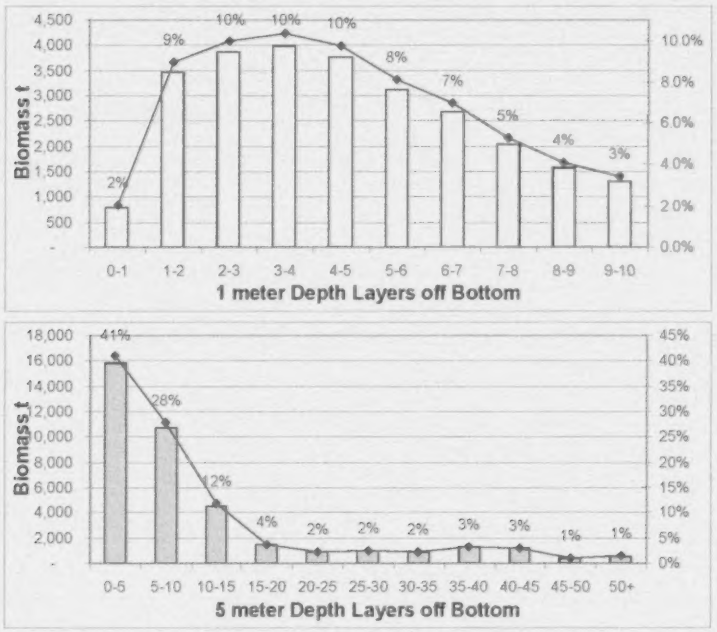

Figure 9A. Distribution of biomass by depth layer from bottom for Scots Bay acoustic survey (#2) on July 16, 2011. Biomass is histogram bars and percent is a line for total biomass by 1m layers from 0m to 9m (top panel) and by 5m layers from bottom to surface (bottom panel).

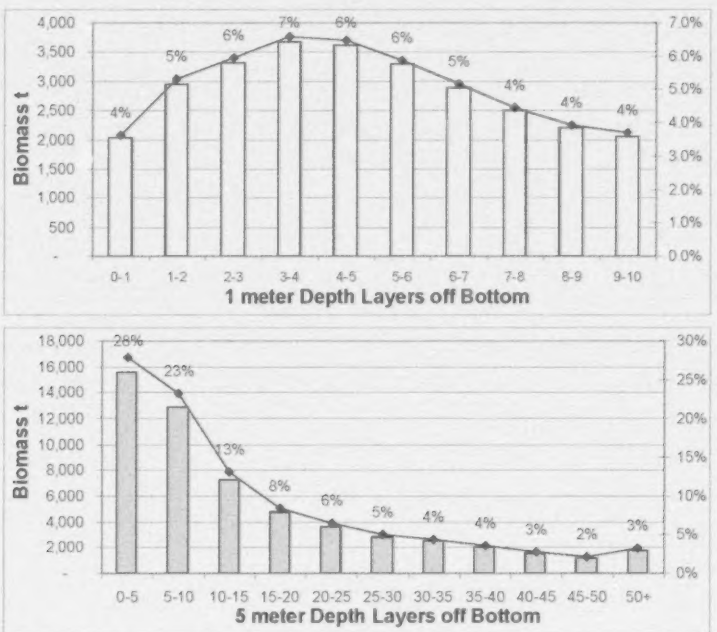

Figure 9B. Distribution of biomass by depth layer from bottom for Scots Bay acoustic survey (#2) on July 14, 2012. Biomass is histogram bars and percent is a line for total biomass by 1m layers from 0m to 9m (top panel) and by 5m layers from bottom to surface (bottom panel).

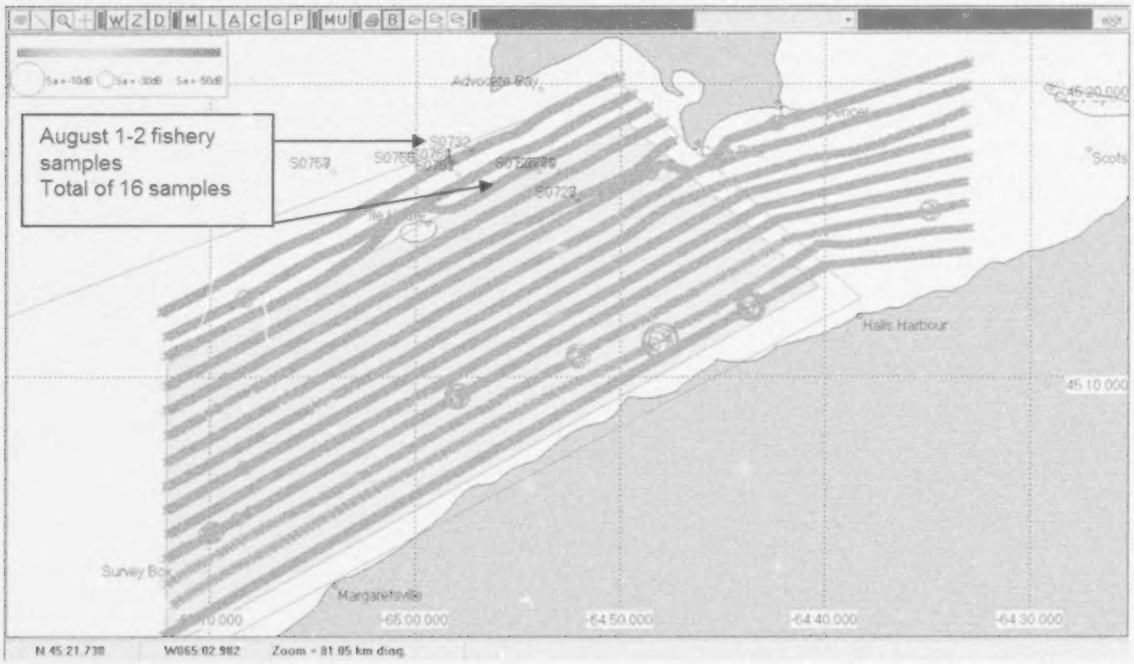

Figure 10A. Scots Bay acoustic survey (#3) on July 30, 2011, showing the main survey box (highlighted area) and transects completed with backscatter (Sa) along with locations of fishery samples.

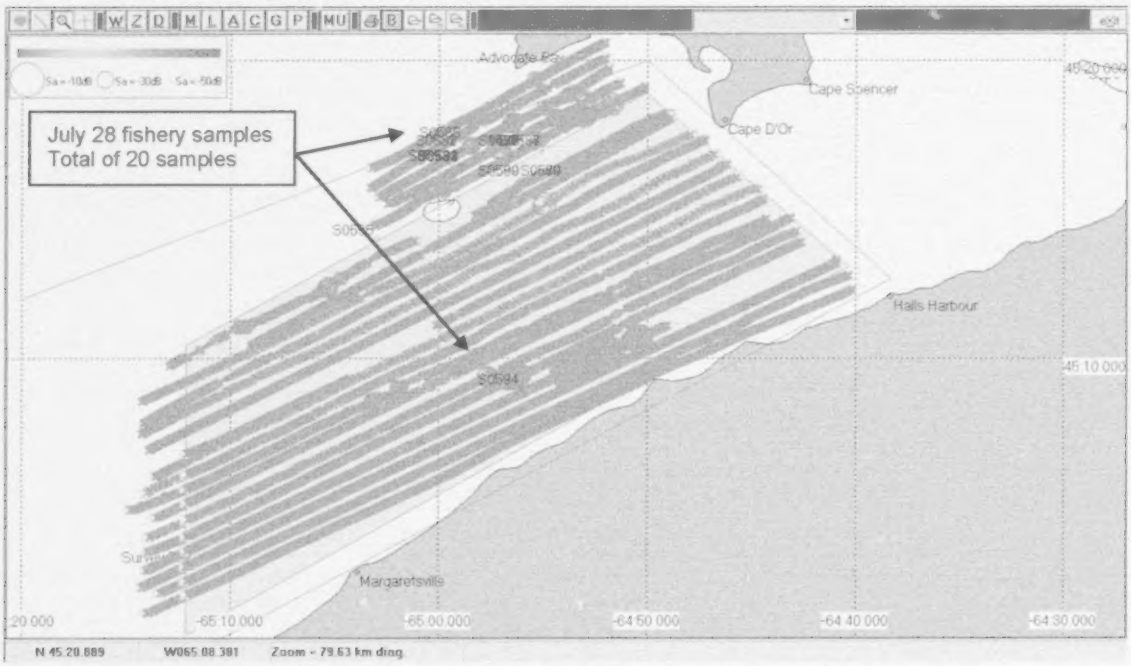

Figure 10B. Scots Bay acoustic survey (#3) on July 28, 2012, showing the main survey box (highlighted area) and transects completed with backscatter (Sa) along with locations of fishery samples.

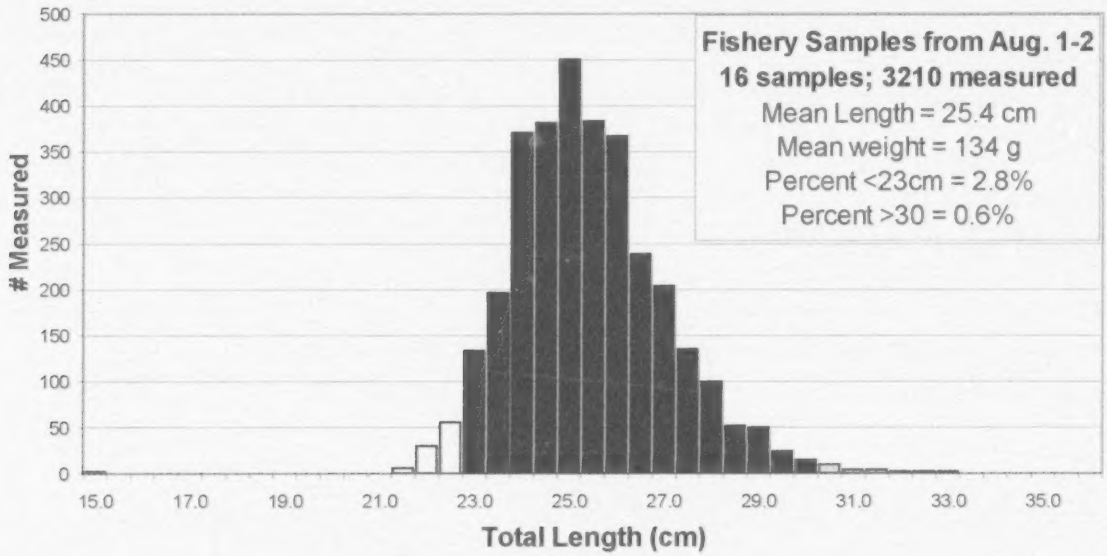

Figure 11A. Length distribution used for calculation of TS for the Scots Bay acoustic survey (#3) on July 30, 2011, from sampling on August 1-2, with proportions <23cm and >30cm shown as white and grey bars.

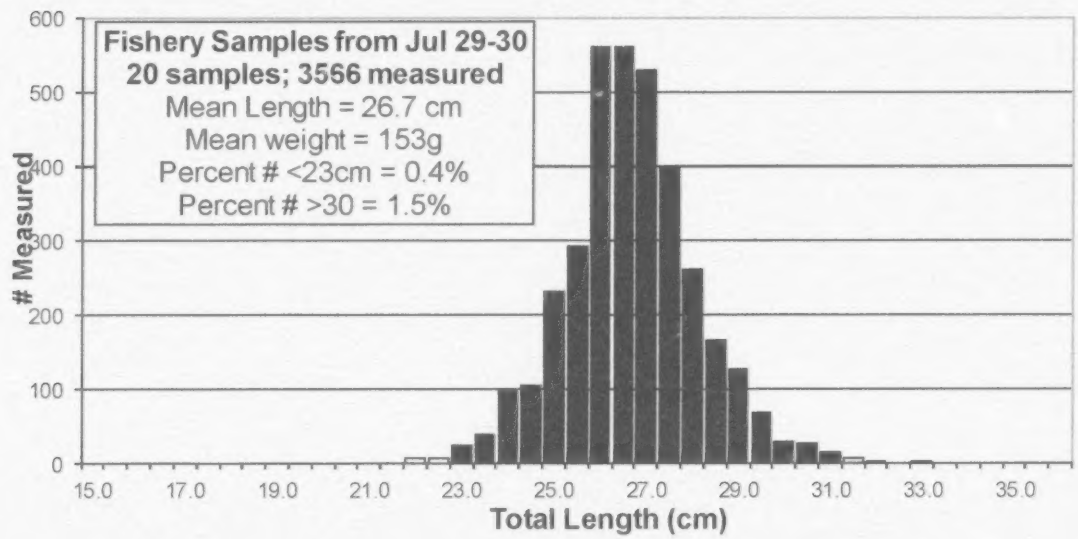

Figure 11B. Length distribution used for calculation of TS for the Scots Bay acoustic survey (#3) on July 28, 2012, from sampling on July 29-30, with proportions <23cm and >30cm shown as white and grey bars.

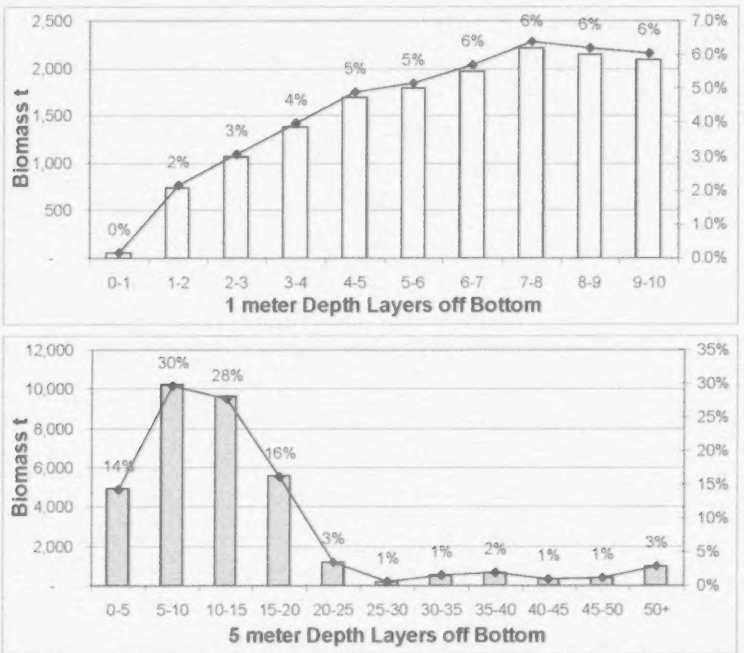

Figure 12A. Distribution of biomass by depth layer from bottom for the Scots Bay acoustic survey (#3) on July 30, 2011. Biomass is shown as histogram bars and percent as a line for total biomass by 1m layers from 0m to 9m (top panel) and by 5m layers from bottom to surface (bottom panel).

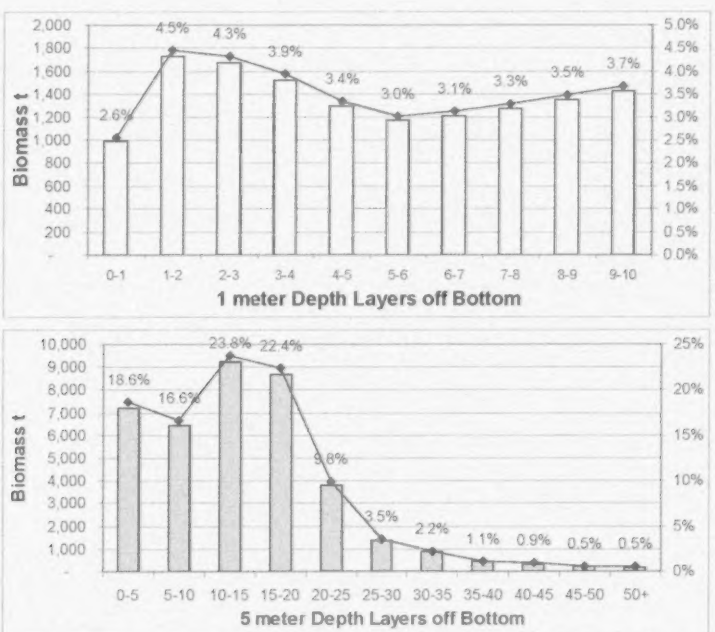

Figure 12B. Distribution of biomass by depth layer from bottom for the Scots Bay acoustic survey (#3) on July 28, 2012. Biomass is shown as histogram bars and percent as a line for total biomass by 1m layers from 0m to 9m (top panel) and by 5m layers from bottom to surface (bottom panel).

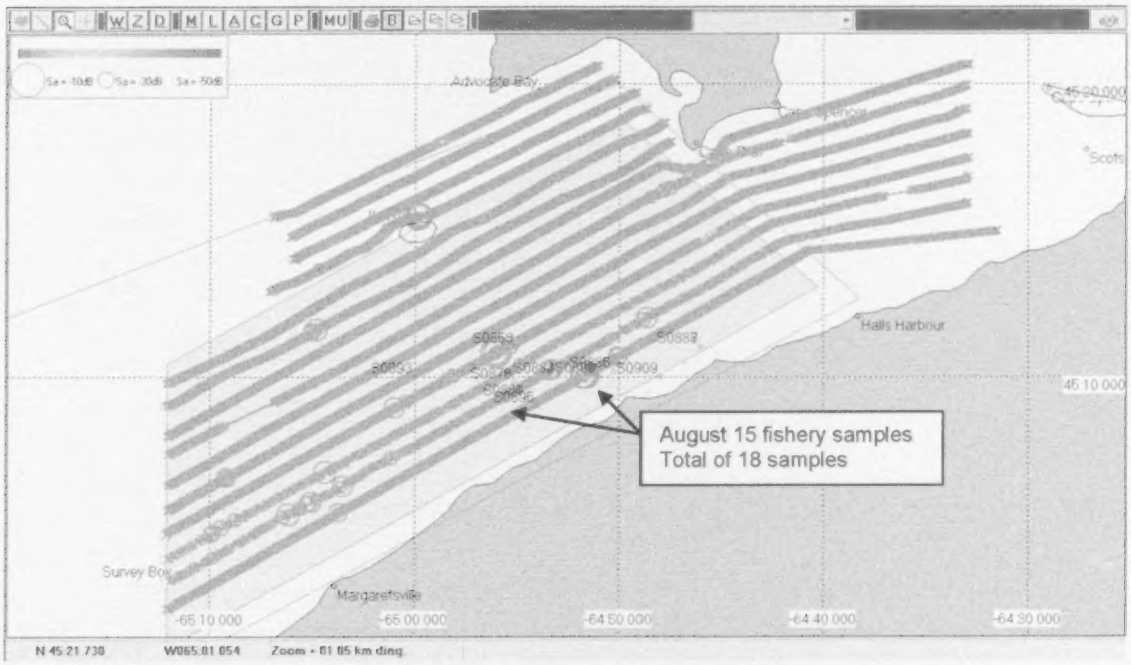

Figure 13A. Scots Bay acoustic survey (#4) on August 13, 2011, showing the main survey box (highlighted area) and transects completed with backscatter (Sa) along with locations of fishery samples.

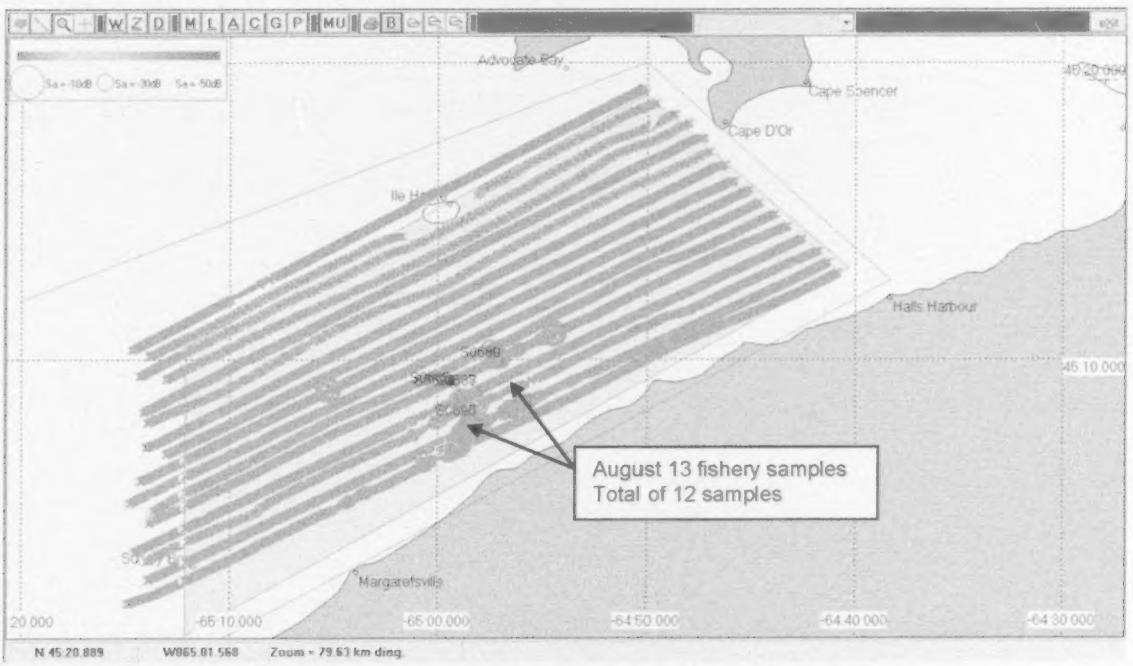

Figure 13B. Scots Bay acoustic survey (#4) on August 11, 2012, showing the main survey box (highlighted area) and transects completed with backscatter (Sa) along with locations of fishery samples.

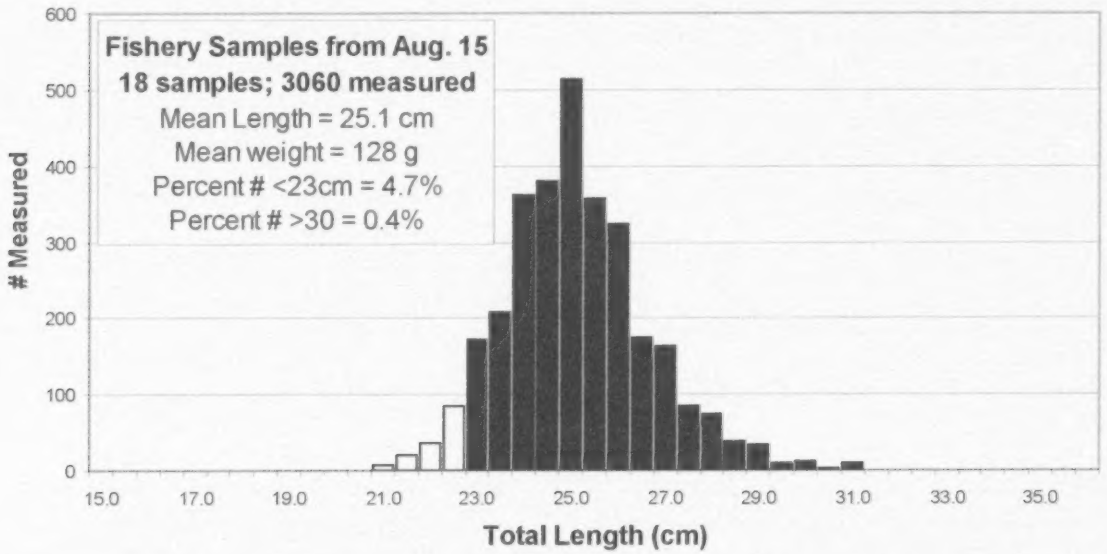

Figure 14A. Length distribution used for calculation of TS for the Scots Bay acoustic survey (#4) on August 13, 2011, from sampling on August 15, with proportions <23cm and >30cm shown as white and grey bars.

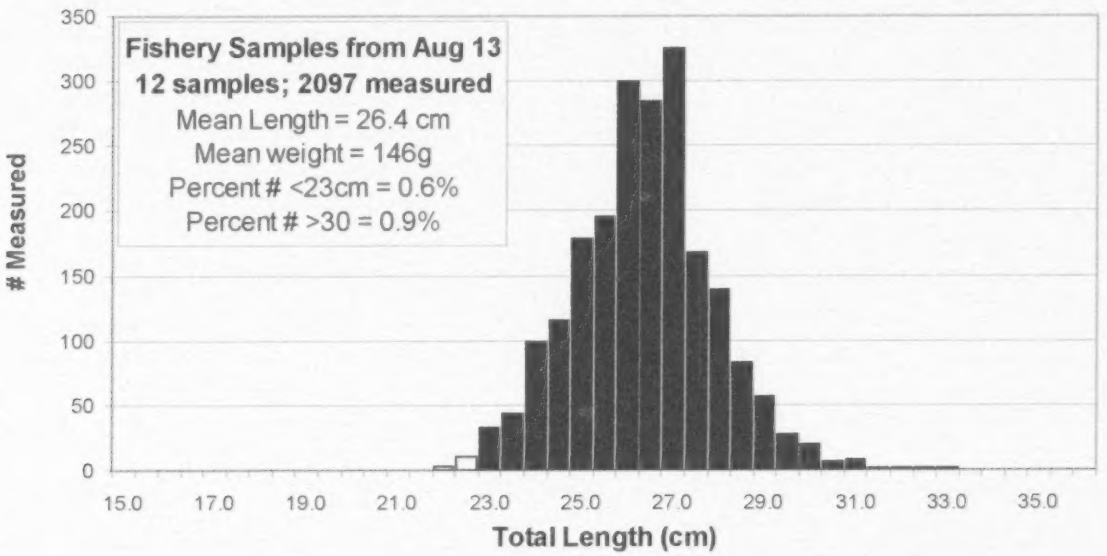

Figure 14B. Length distribution used for calculation of TS for the Scots Bay acoustic survey (#4) on August 11, 2012, from sampling on August 13, with proportions <23cm and >30cm shown as white and grey bars.

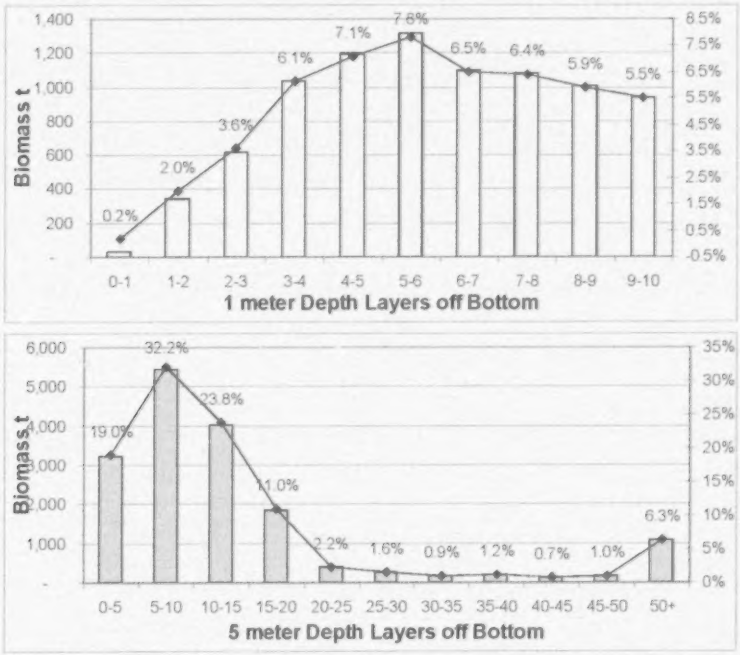

Figure 15A. Distribution of biomass by depth layer from bottom for the Scots Bay acoustic survey (#4) on August 13, 2011. Biomass is shown as histogram bars and percent as a line for total biomass by 1m layers from 0m to 9m (top panel) and by 5m layers from bottom to surface (bottom panel).

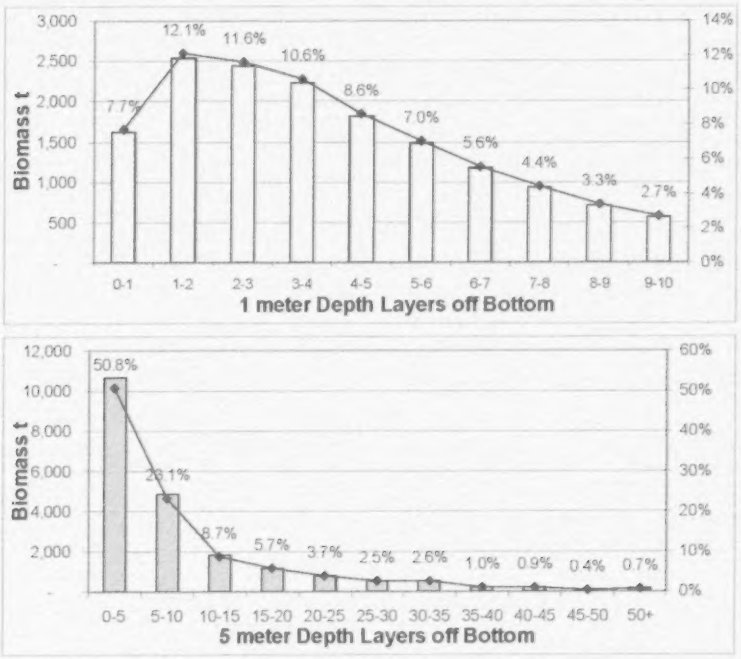

Figure 15B. Distribution of biomass by depth layer from bottom for the Scots Bay acoustic survey (#4) on August 11, 2012. Biomass is shown as histogram bars and percent as a line for total biomass by 1m layers from 0m to 9m (top panel) and by 5m layers from bottom to surface (bottom panel).

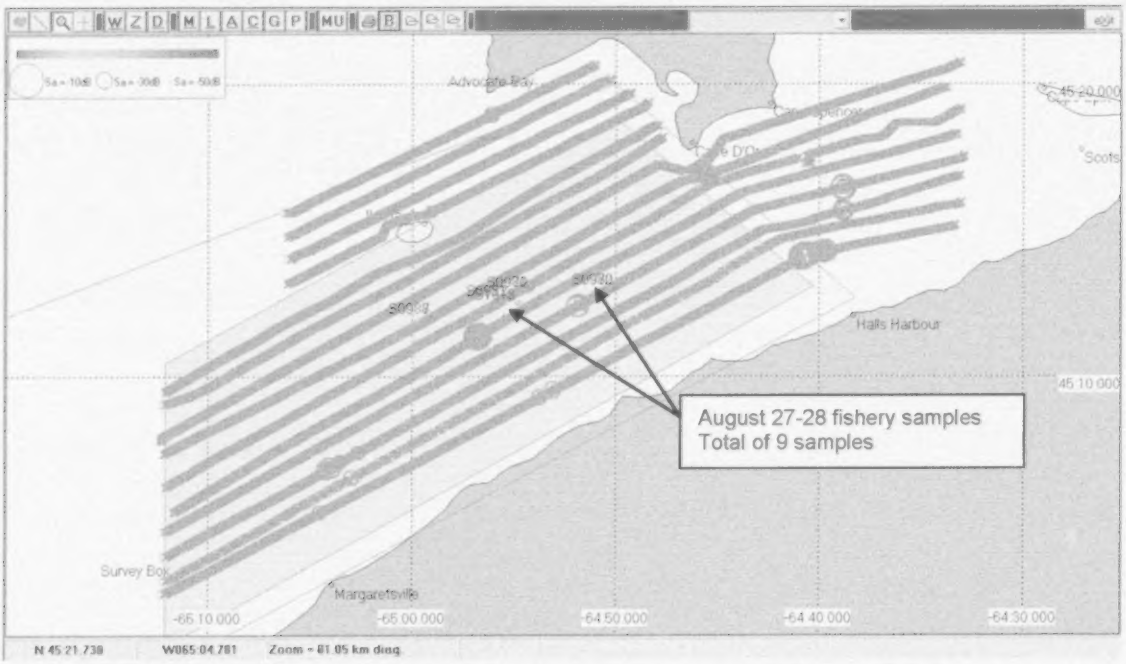

Figure 16A. Scots Bay acoustic survey (#5) on August 26, 2011, showing the main survey box (highlighted area) and transects completed with backscatter (Sa) along with locations of fishery samples.

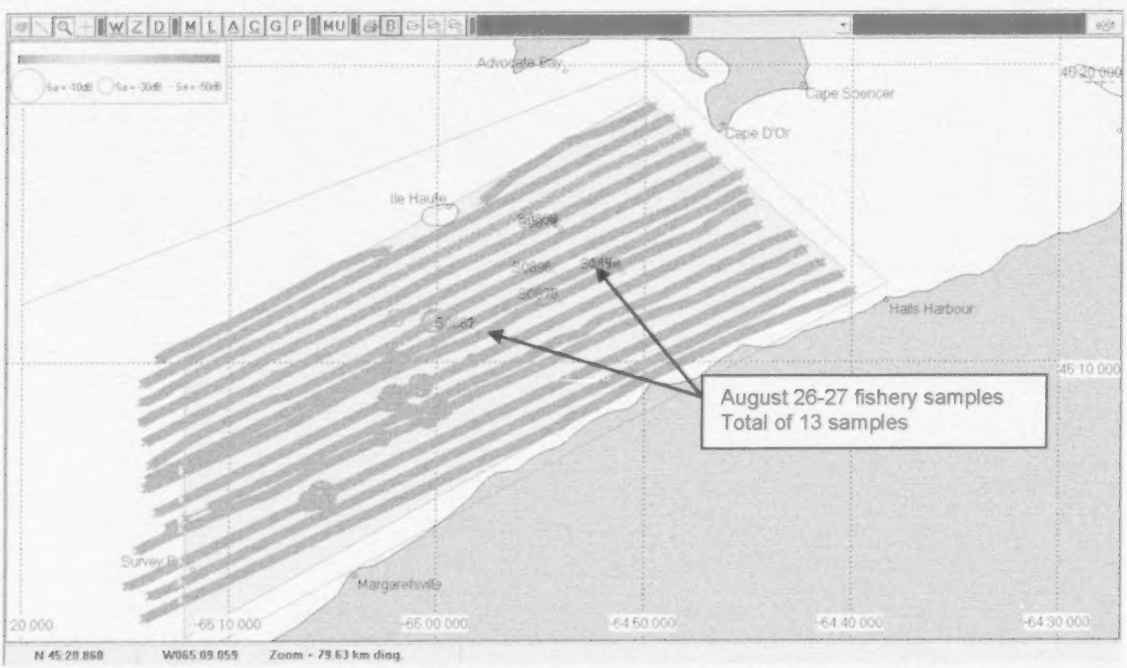

Figure 16B. Scots Bay acoustic survey (#5) on August 25, 2012, showing the main survey box (highlighted area) and transects completed with backscatter (Sa) along with locations of fishery samples.

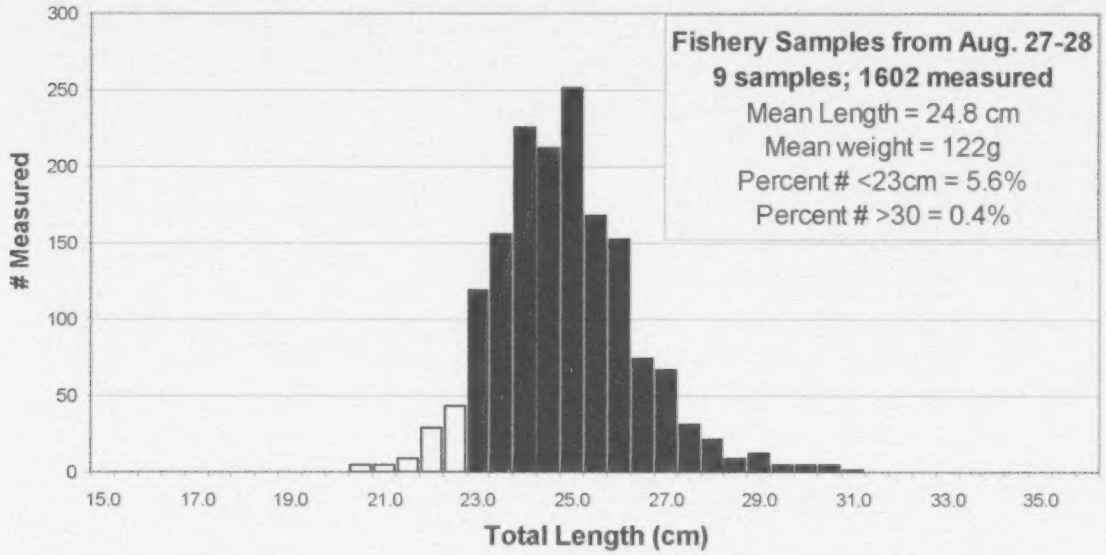

Figure 17A. Length distribution used for calculation of TS for the Scots Bay acoustic survey (#5) on August 26, 2011, from sampling on August 27-28, with proportions <23cm and >30cm shown as white and grey bars.

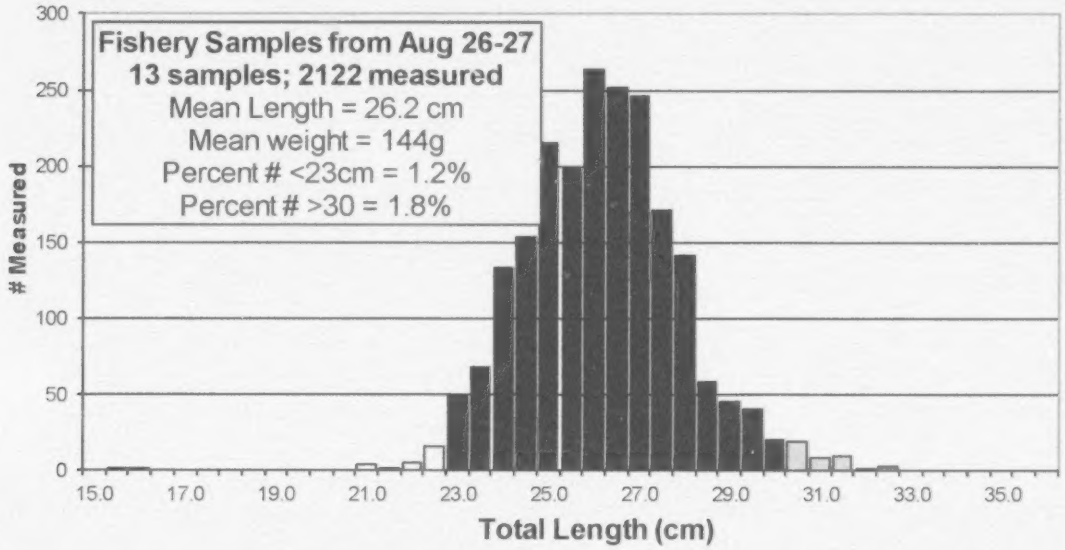

Figure 17B. Length distribution used for calculation of TS for the Scots Bay acoustic survey (#5) on August 25, 2012, from sampling on August 26-27, with proportions <23cm and >30cm shown as white and grey bars.

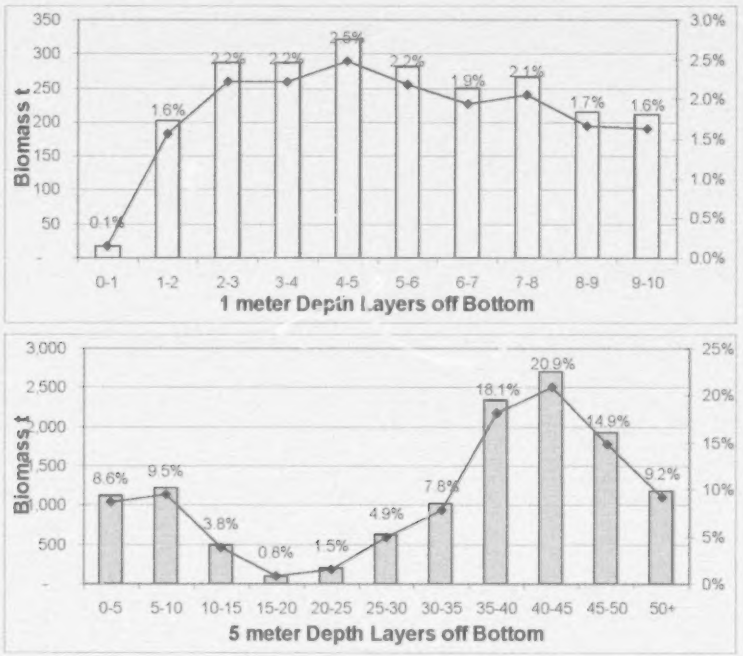

Figure 18A. Distribution of biomass by depth layer from bottom for the Scots Bay acoustic survey (#5) on August 26, 2011. Biomass is shown as histogram bars and percent as a line for total biomass by 1m layers from 0m to 9m (top panel) and by 5m layers from bottom to surface (bottom panel).

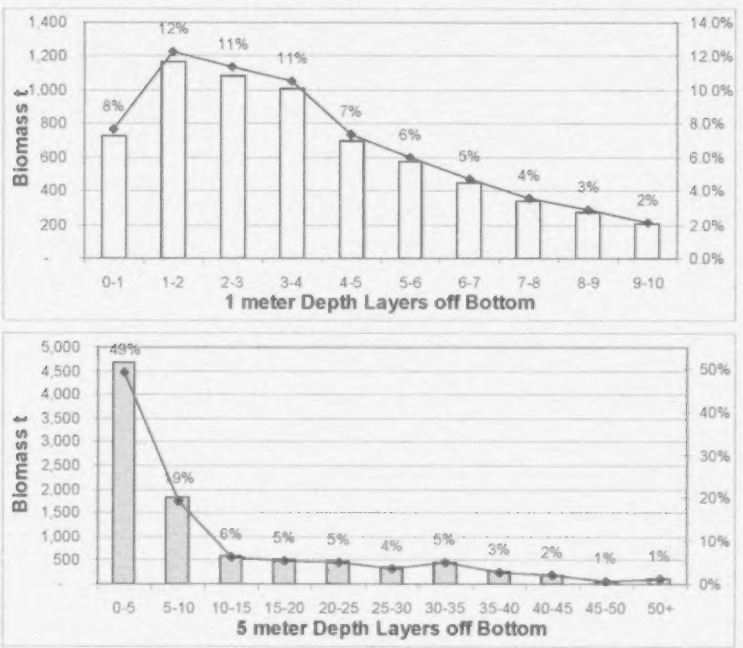

Figure 18B. Distribution of biomass by depth layer from bottom for the Scots Bay acoustic survey (#5) on August 25, 2012. Biomass is shown as histogram bars and percent as a line for total biomass by 1m layers from 0m to 9m (top panel) and by 5m layers from bottom to surface (bottom panel).

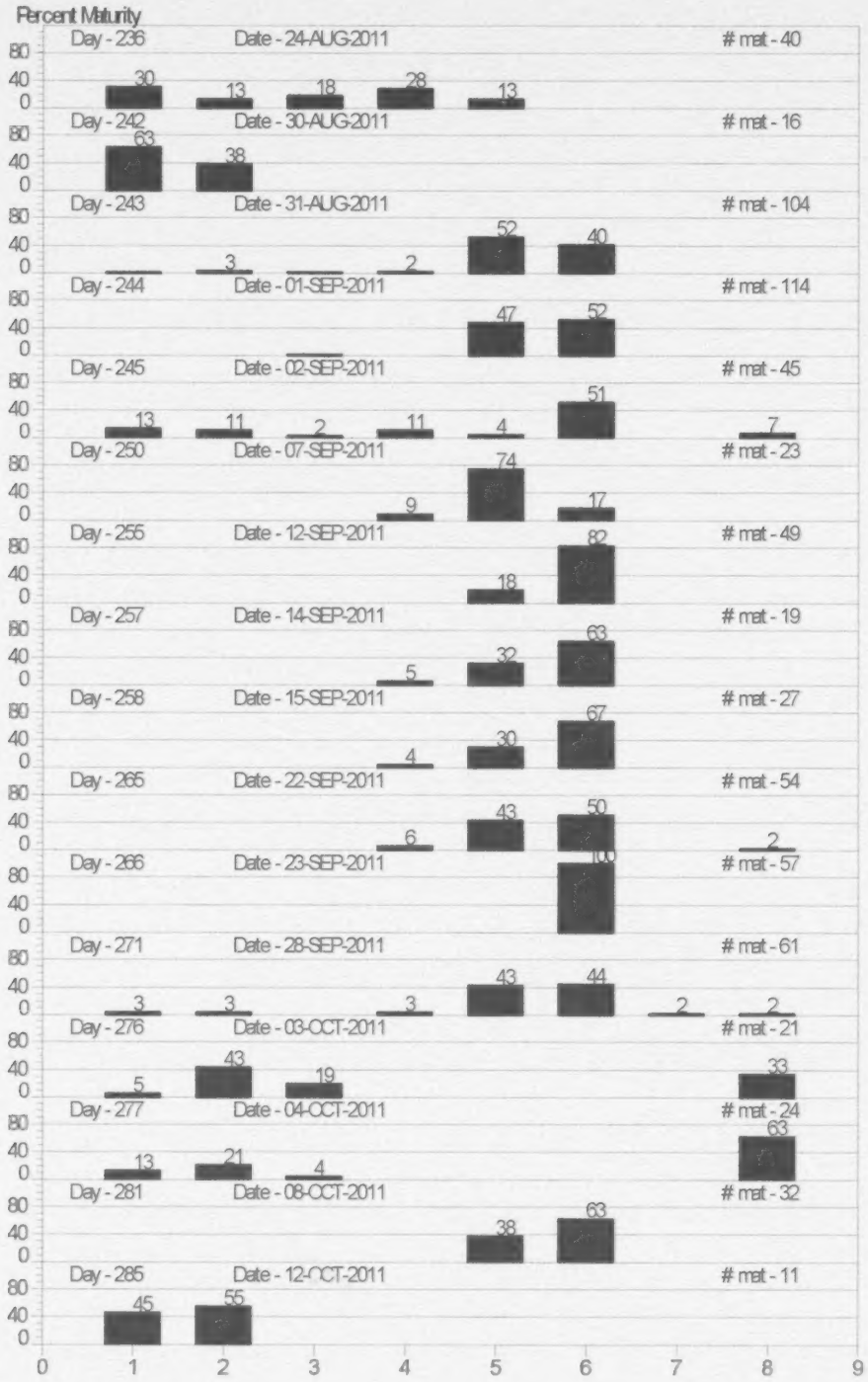

Figure 19A. Daily herring maturity samples collected from German Bank survey box area in 2011. (Staging codes 1-2=immature; 3-4-5=maturing/hard; 6=ripe and running; 7=spent; 8=recovering). Includes research midwater trawl samples collected by the Alfred Needler from August 30 to September 1 (NED2011-035).

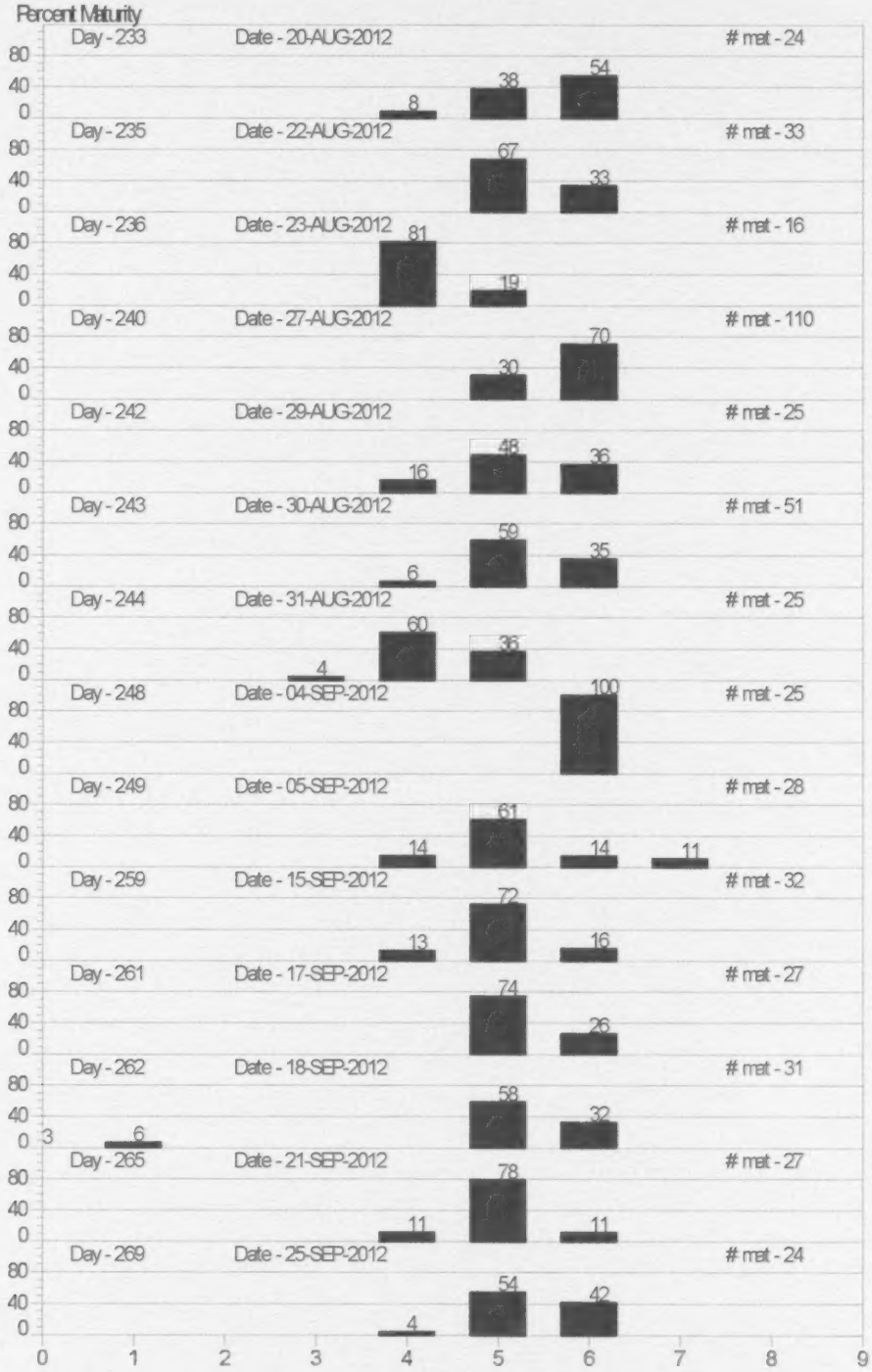

Figure 19B (continued below). Daily herring maturity samples collected from German Bank survey box area in 2012 from August 20 to September 25. (Staging codes 1-2=immature; 3-4-5=maturing/hard; 6=ripe and running; 7=spent; 8=recovering).

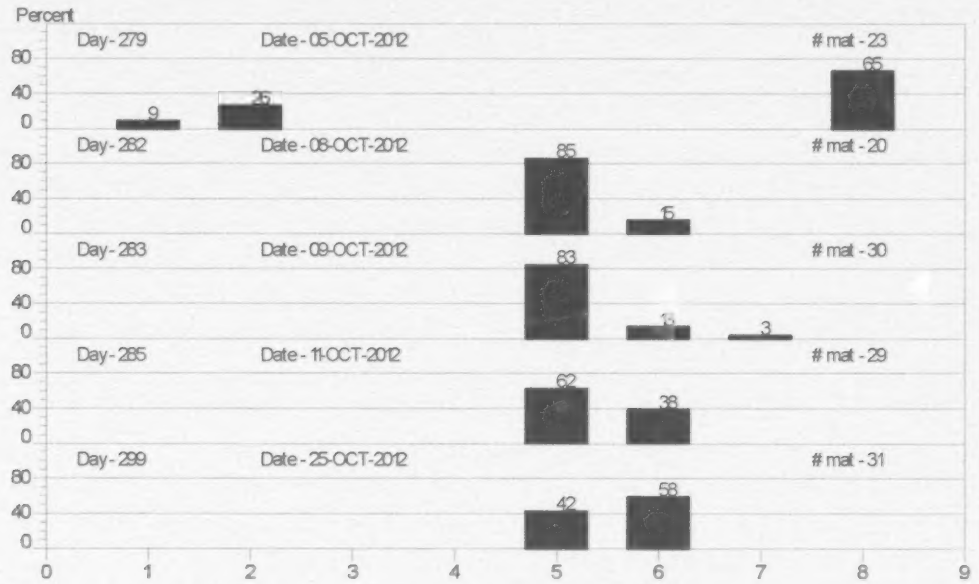

Figure 19B (continued from above). Daily herring maturity samples collected from German Bank survey box area in 2012 from October 5-25. (Staging codes 1-2=immature; 3-4-5=maturing/hard; 6=ripe and running; 7=spent; 8=recovering).

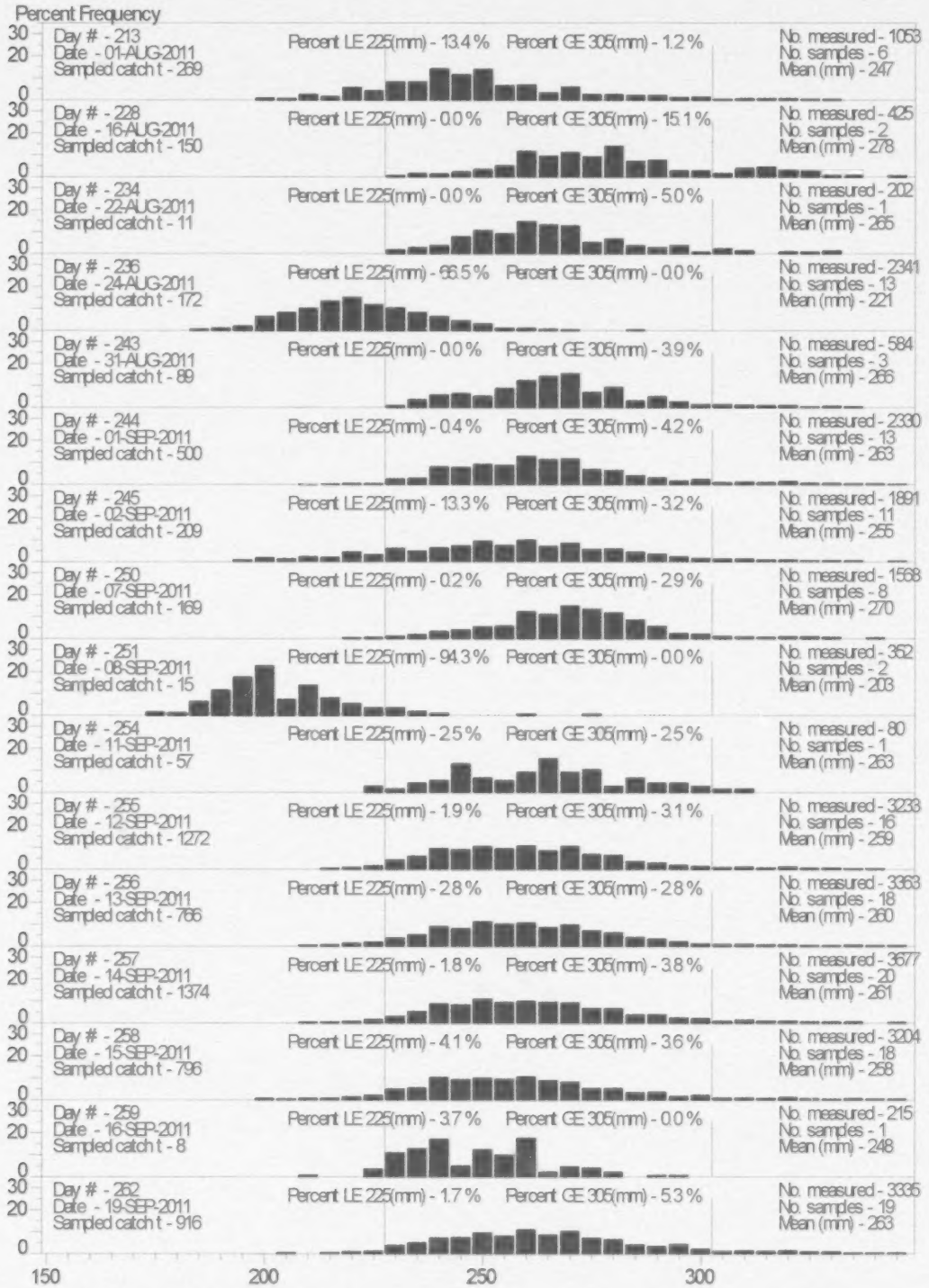

Figure 20A (continued below). Daily herring length frequency samples collected from 2011 German Bank survey box area for period from August 1 to September 19, with proportions <23cm and >30cm.

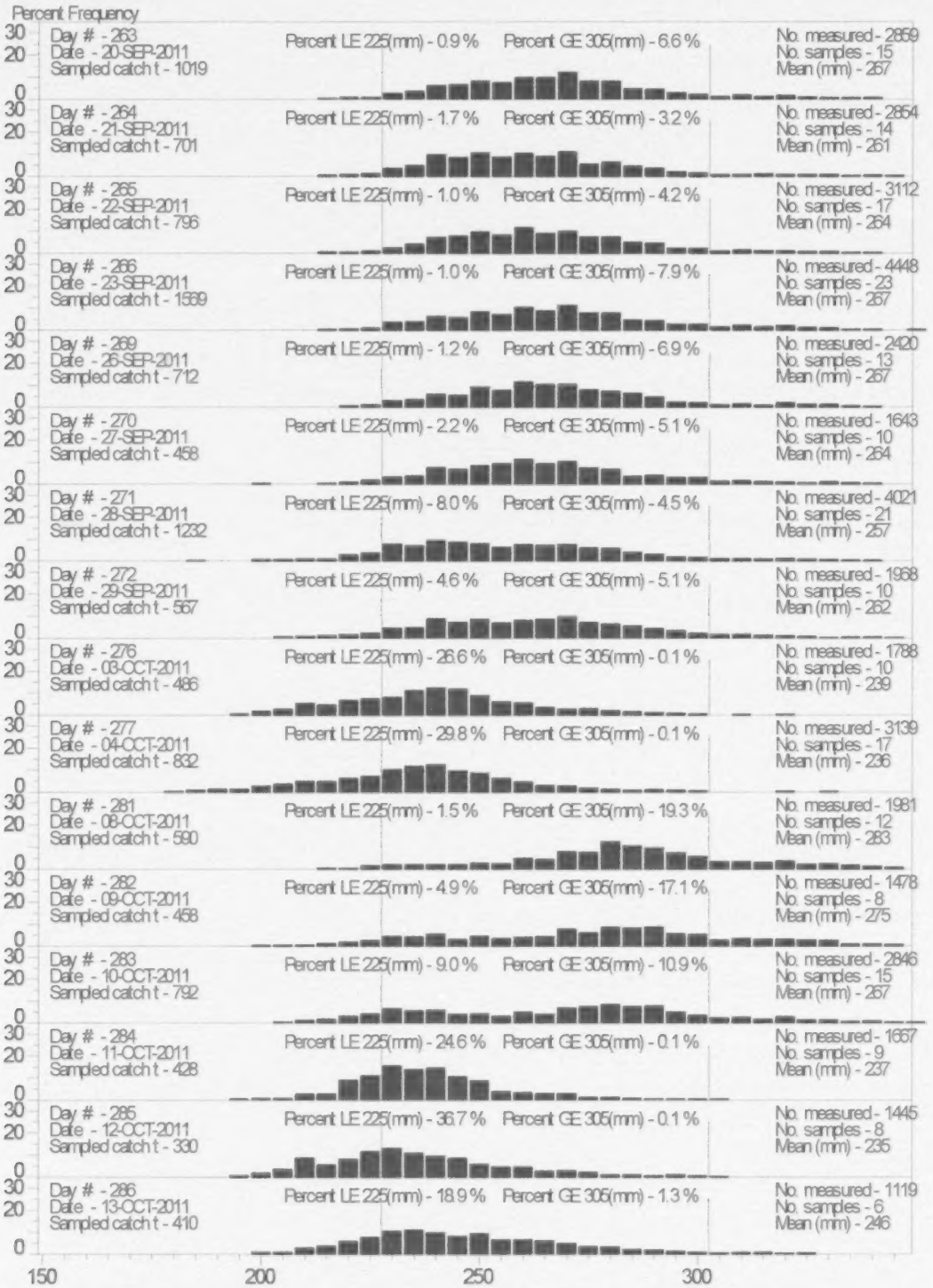

Figure 20A (continued from above). Daily herring length frequency samples collected from 2011 German Bank survey box area for period from September 20 to October 13, with proportions <23cm and >30cm.

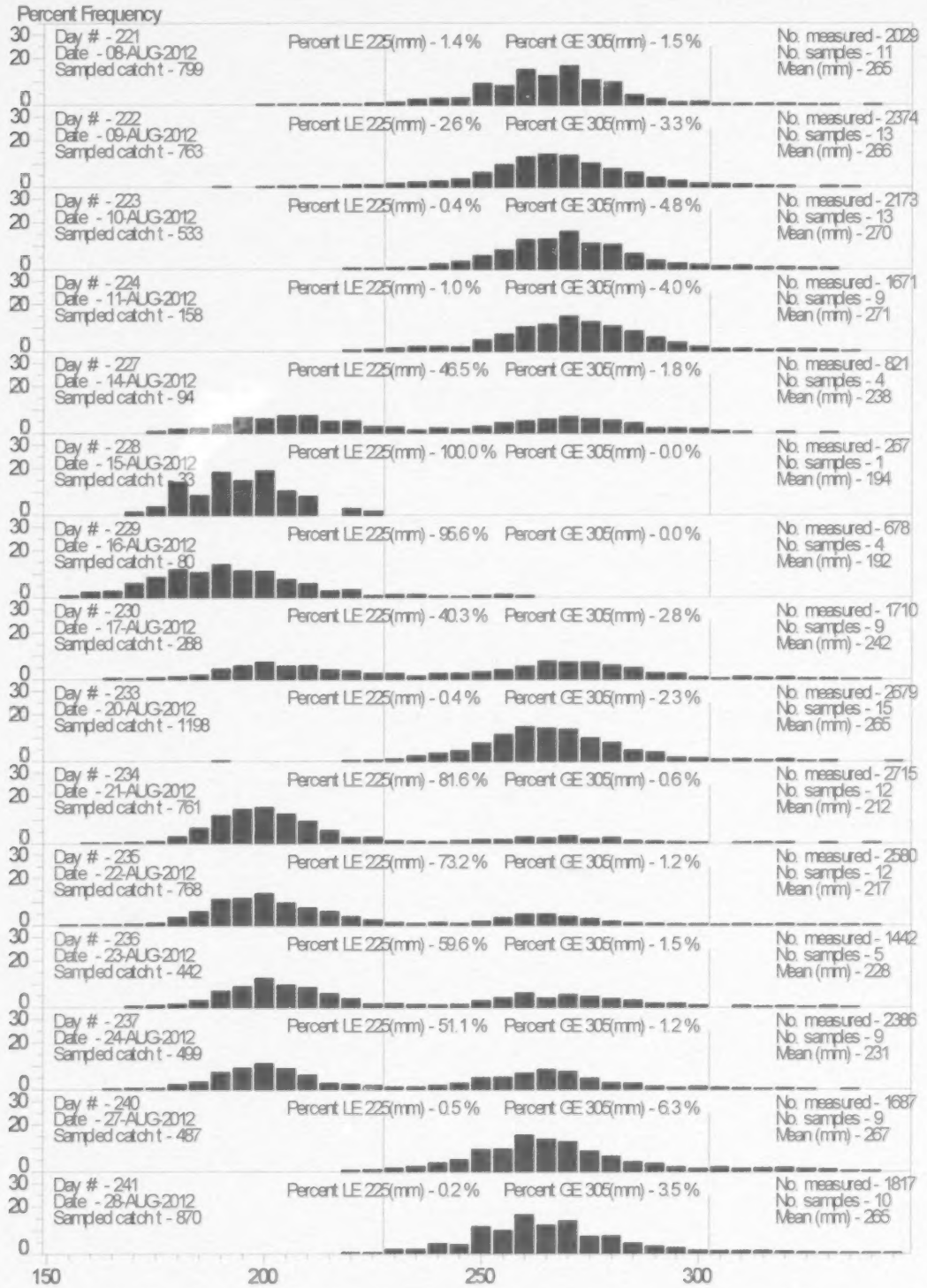

Figure 20B (continued below). Daily herring length frequency samples collected from 2012 German Bank survey box area for period from August 8-28, with proportions <23cm and >30cm.

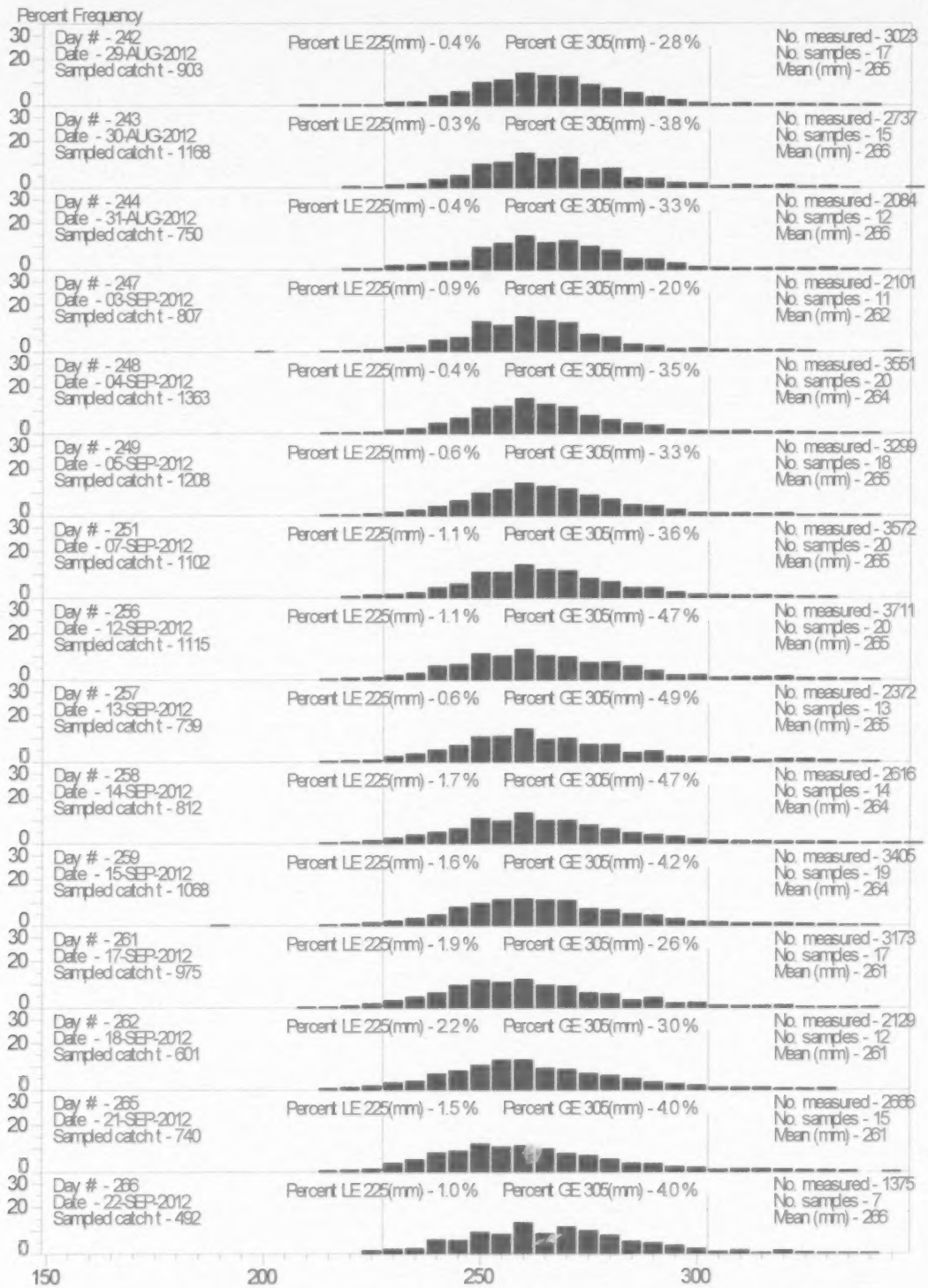

Figure 20B (continued from above and continued below). Daily herring length frequency samples collected from 2012 German Bank survey box area for period from August 29 to September 22, with proportions <23cm and >30cm.

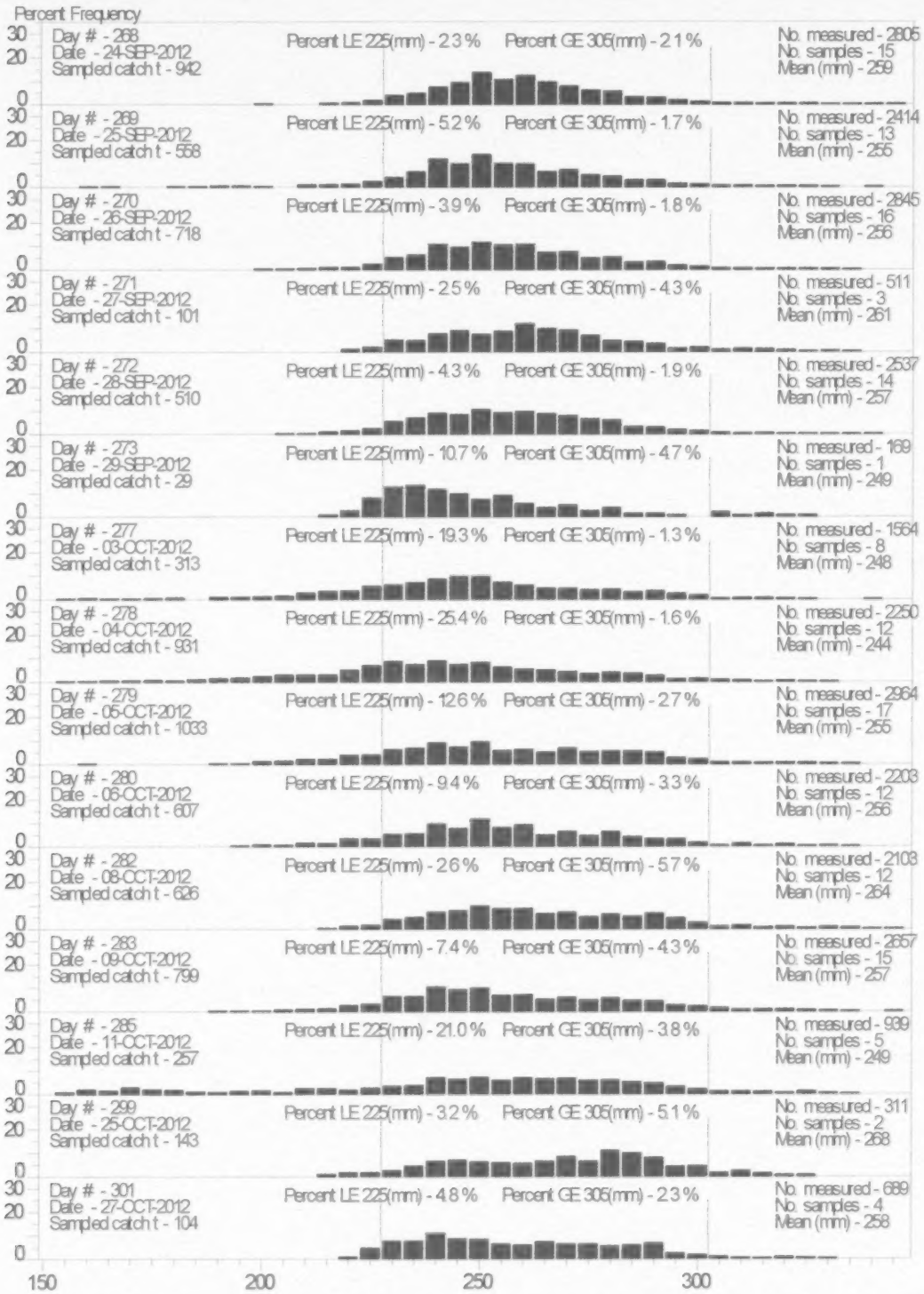

Figure 20B (continued from above). Daily herring length frequency samples collected from 2012 German Bank survey box area for period from September 24 to October 27, with proportions <23cm and >30cm.

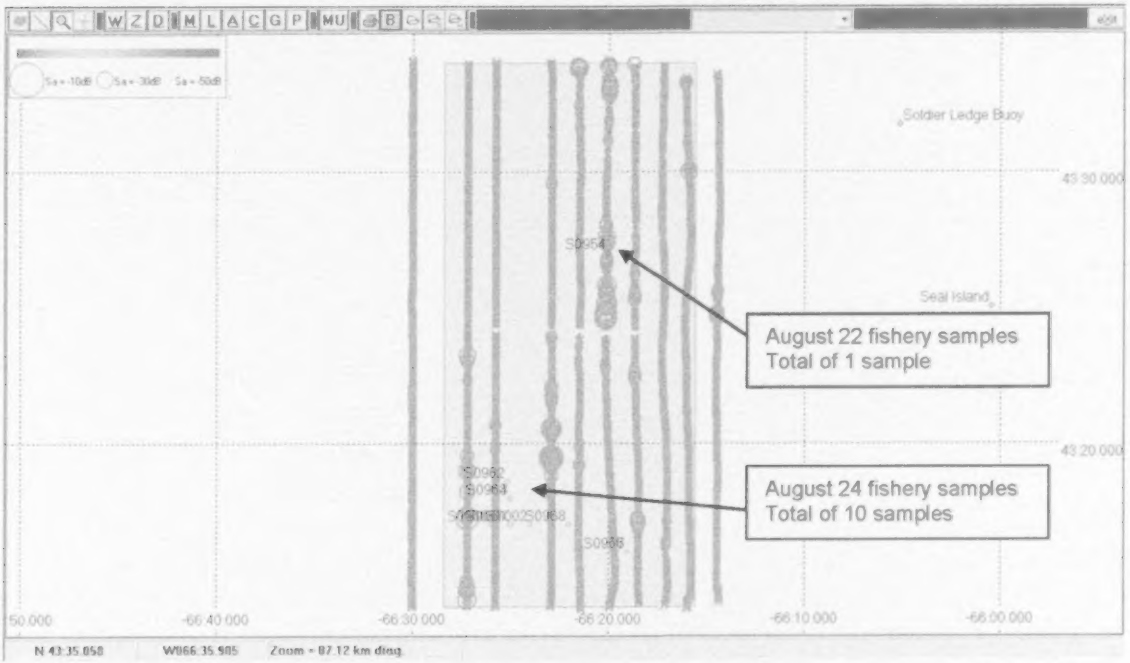

Figure 21A. German Bank acoustic survey (#1) on August 26, 2011, with transects showing location and backscatter (Sa) in the main survey box (highlighted area) along with locations of samples used in calculation of TS.

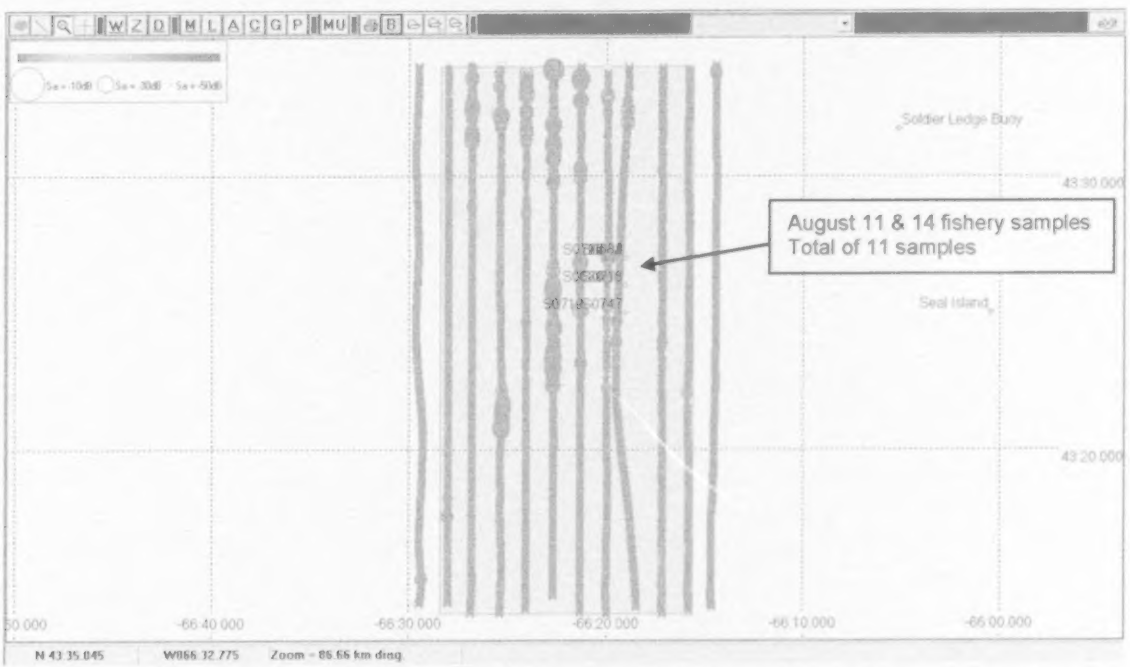

Figure 21B. German Bank acoustic survey (#1) on August 12, 2012, with transects showing location and backscatter (Sa) in the main survey box (highlighted area) along with locations of samples used in calculation of TS.

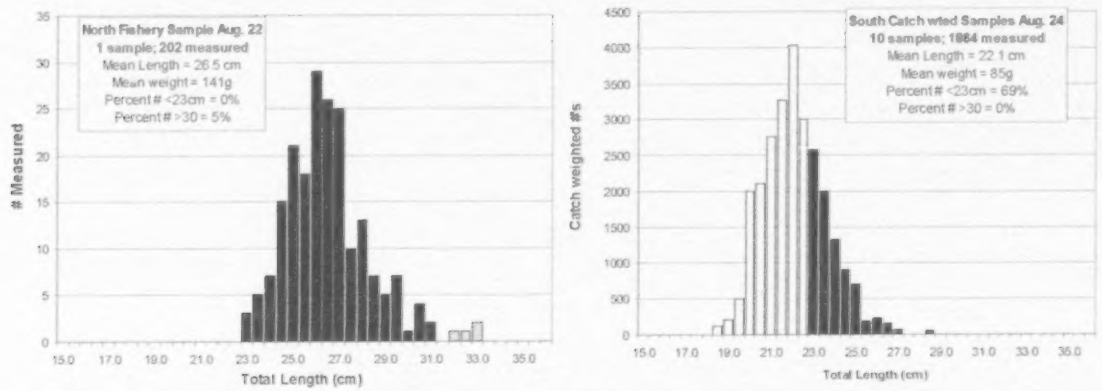

Figure 22A. Length distribution used for calculation of TS for the German Bank acoustic survey (#1) on August 26, 2011, from sampling during on August 22-24, with proportions <23cm and >30cm shown as white and grey bars. Samples from the north and south separated and used to generate separate TS for the north and south.

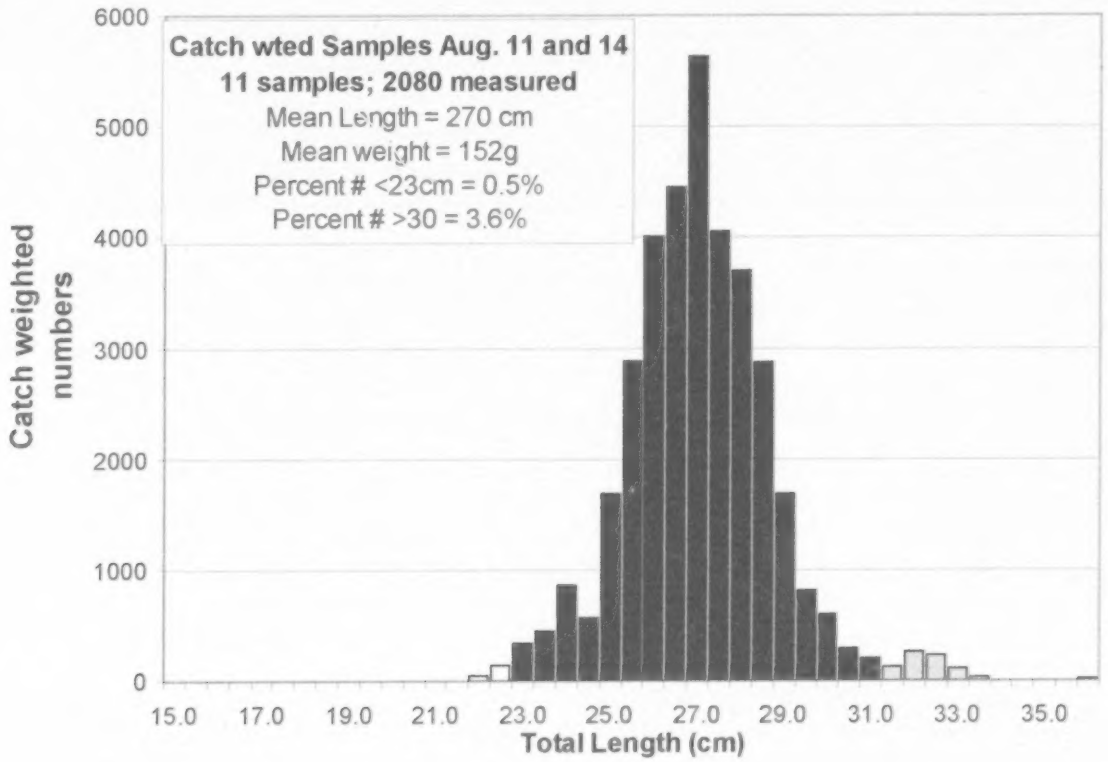

Figure 22B. Length distribution used for calculation of TS for the German Bank acoustic survey (#1) on August 12, 2012, from sampling on August 11-14, with proportions <23cm and >30cm shown as white and grey bars.

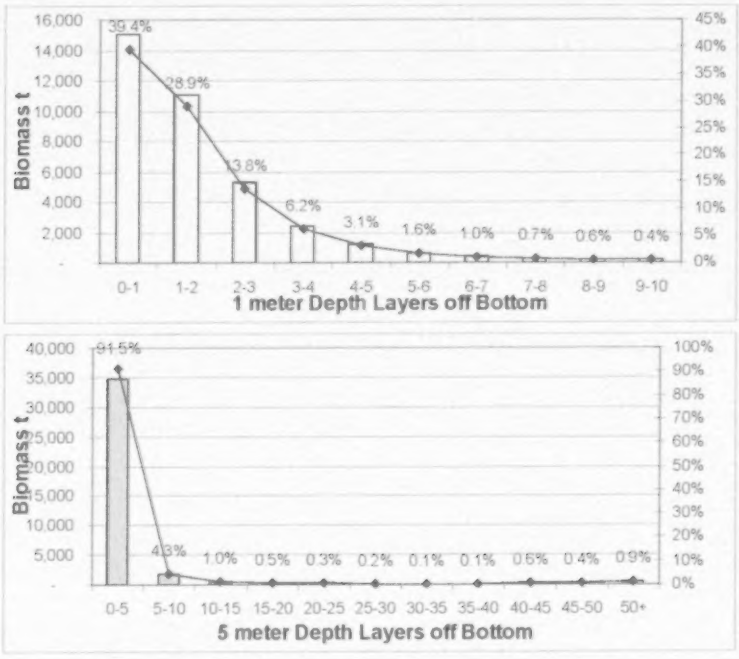

Figure 23A. Distribution of biomass by depth layer from bottom for the German Bank acoustic survey (#1) on August 26, 2011. Biomass and % of total biomass by 1m layers from 0m to 9m (top panel) and by 5m layers from bottom to surface (bottom panel).

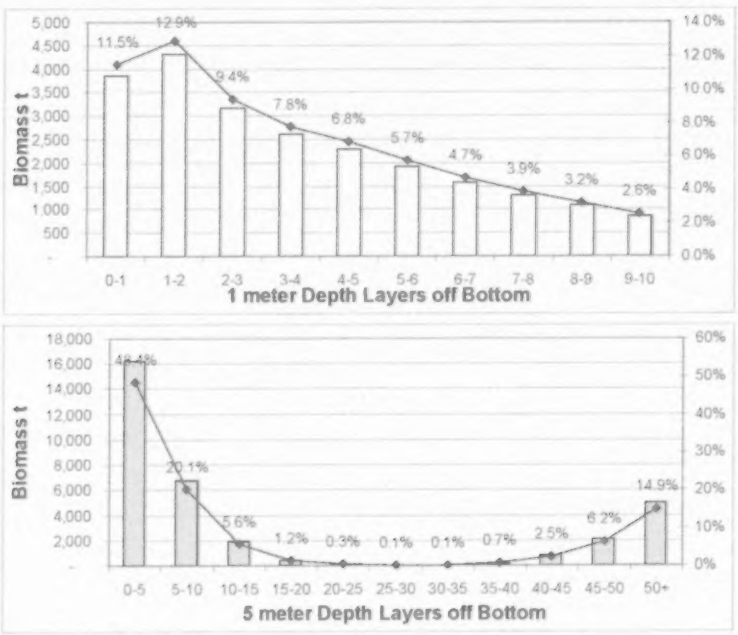

Figure 23B. Distribution of biomass by depth layer from bottom for the German Bank acoustic survey (#1) on August 12, 2012. Biomass and % of total biomass by 1m layers from 0m to 9m (top panel) and by 5m layers from bottom to surface (bottom panel).

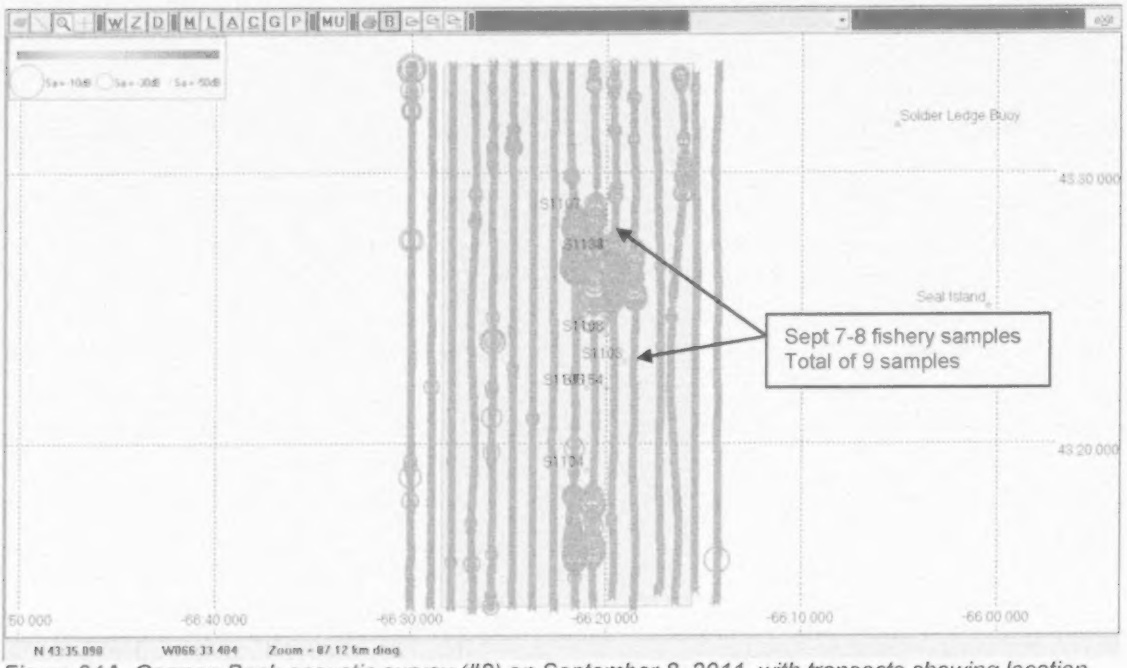

Figure 24A. German Bank acoustic survey (#2) on September 8, 2011, with transects showing location and backscatter (Sa) in the main survey box (highlighted area) along with the locations of fishery samples.

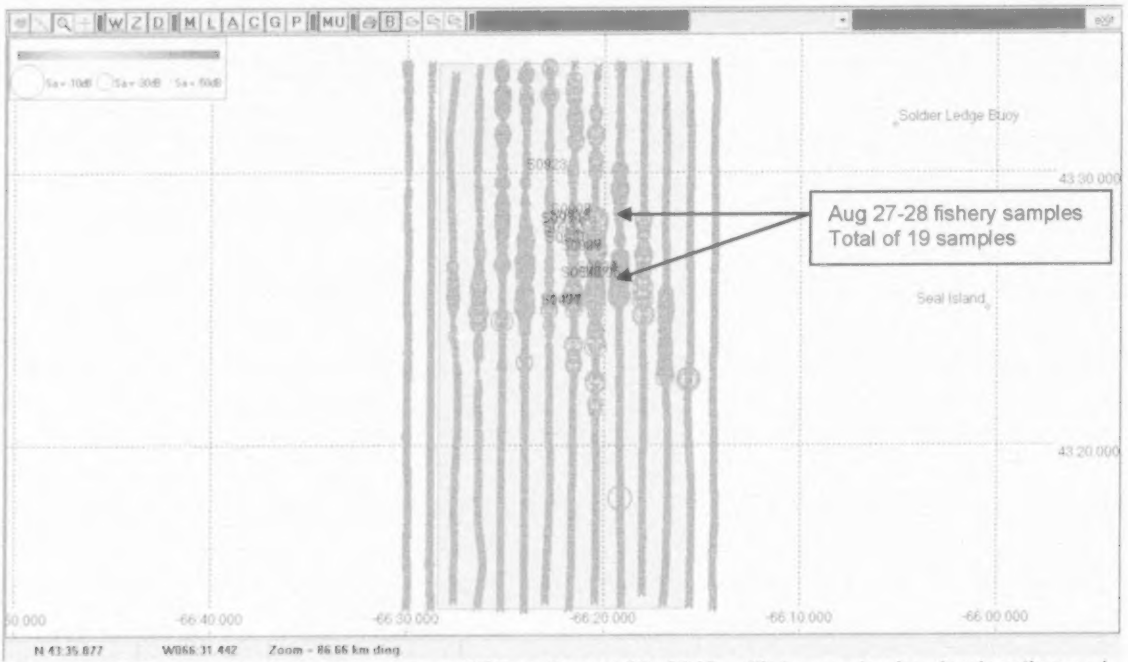

Figure 24B. German Bank acoustic survey (#2) on August 26, 2012, with transects showing location and backscatter (Sa) in the main survey box (highlighted area). Fishery samples are identified by location with sample number.

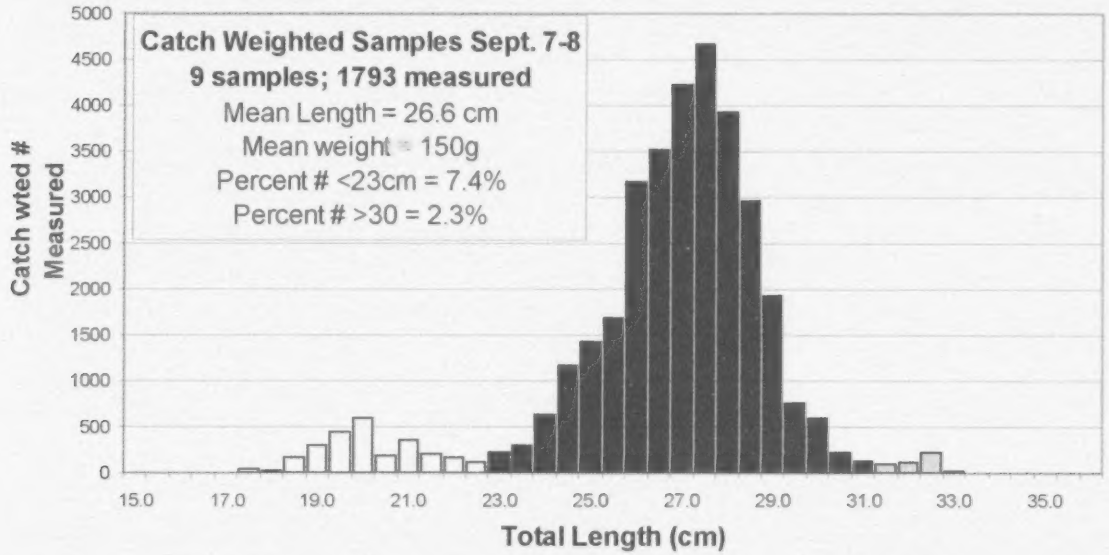

Figure 25A. Length distribution used for final calculation of TS for the German Bank acoustic survey (#2) September 8, 2011, based on September 7-8 sampling from purse seine fishery landings. Note proportions <23cm and >30cm shown as white and grey bars.

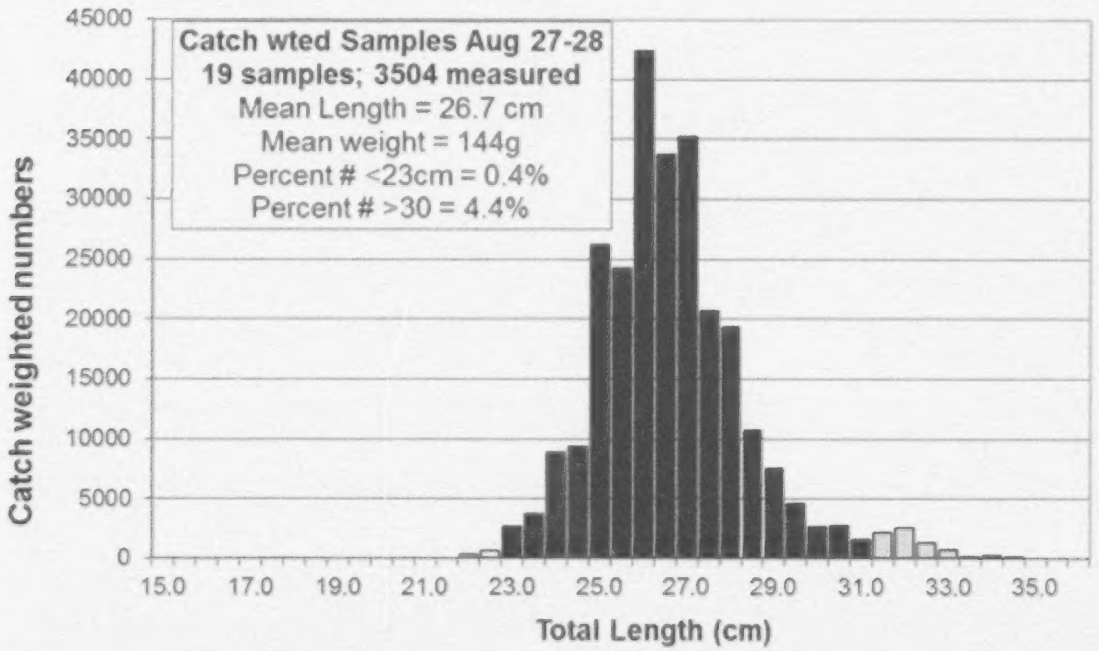

Figure 25B. Length distribution used for final calculation of TS for the German Bank acoustic survey (#2) on August 26, 2012, based on August 27-28 sampling from purse seine fishery landings. Note proportions <23cm and >30cm shown as white and grey bars.

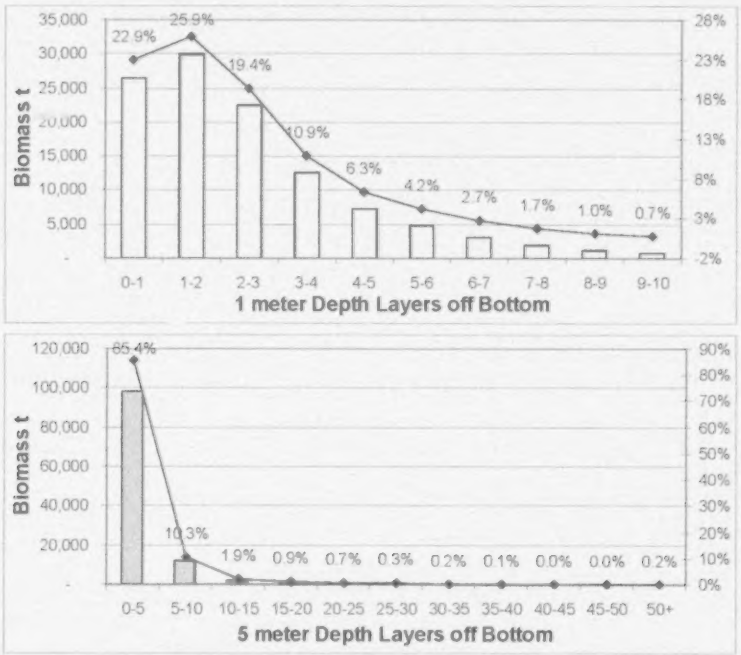

Figure 26A. Distribution of biomass by depth layer from bottom for the German Bank acoustic survey (#2) on September 8, 2011. Biomass and % of total biomass by 1m layers from 0m to 9m (top panel) and by 5m layers from bottom to surface (bottom panel).

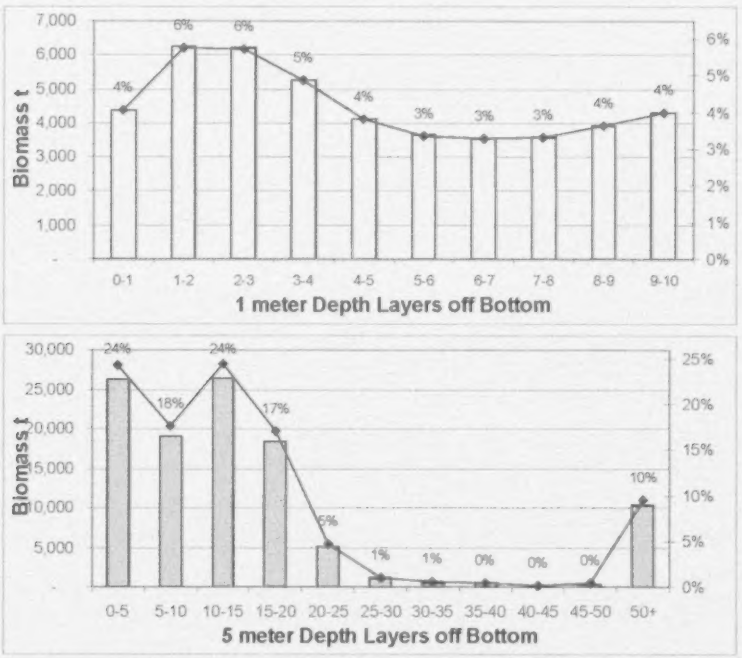

Figure 26B. Distribution of biomass by depth layer from bottom for the German Bank acoustic survey on August 26, 2012. Biomass and % of total biomass by 1m layers from 0m to 9m (top panel) and by 5m layers from bottom to surface (bottom panel).

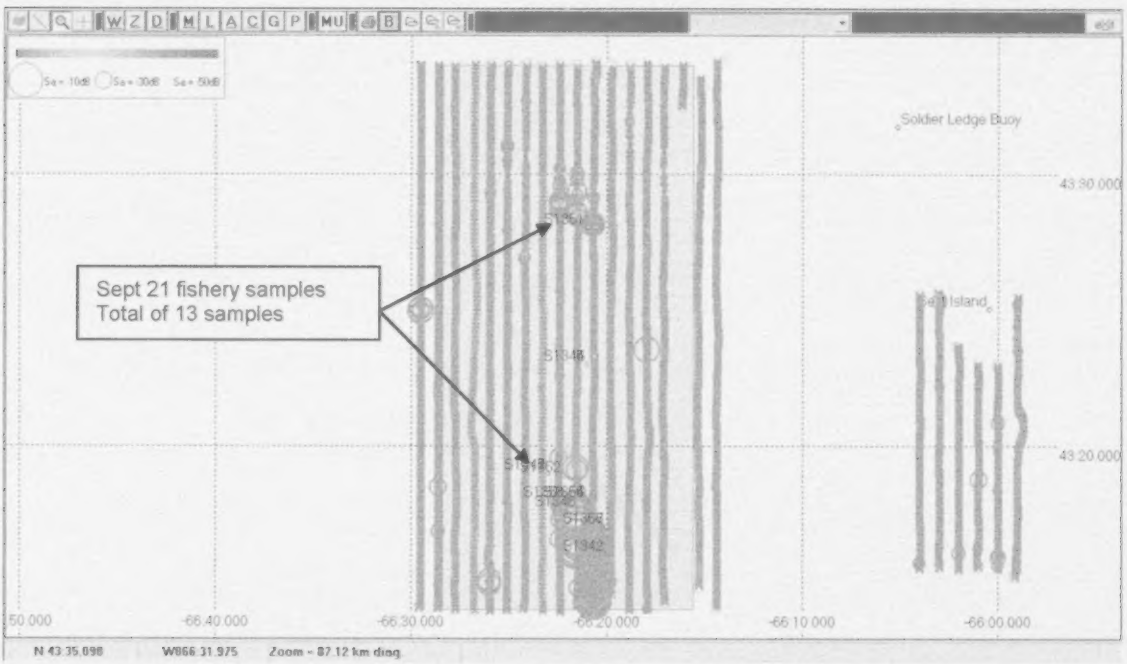

Figure 27A. German Bank acoustic survey (#3) on September 21, 2011, showing the main survey box (highlighted area) and transects with backscatter (Sa) along with the locations of fishery samples. Transects to the west were grouped as Seal Island transects.

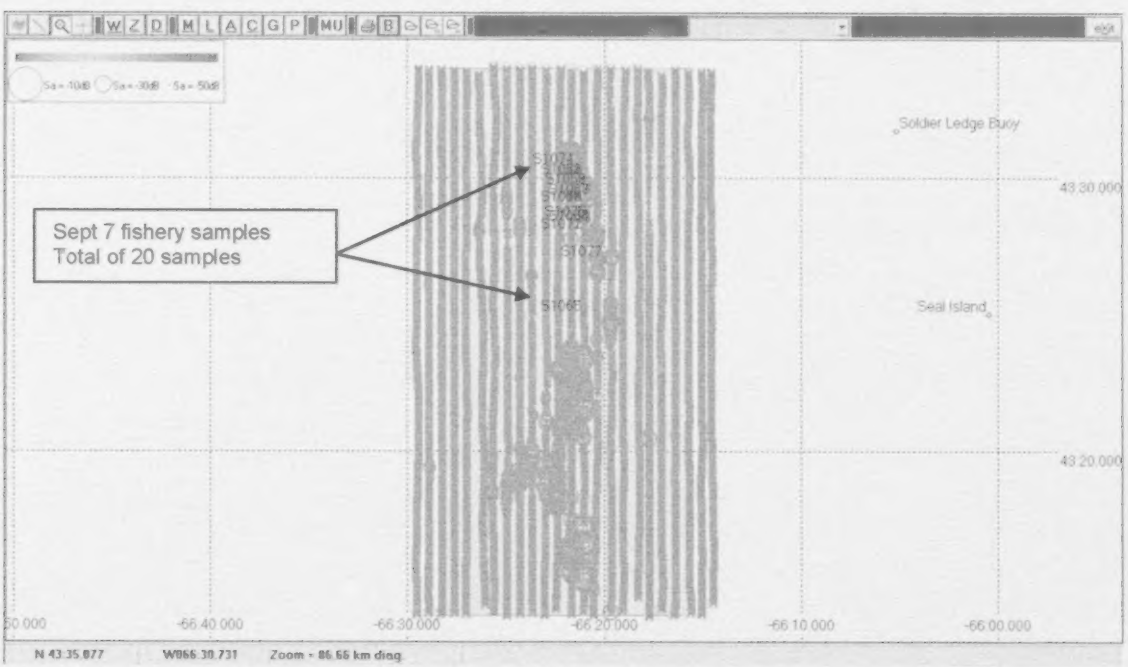

Figure 27B. German Bank acoustic survey (#3) on September 9, 2012, showing the main survey box (highlighted area) and transects with backscatter (Sa) along with locations of fishery samples used for the TS.

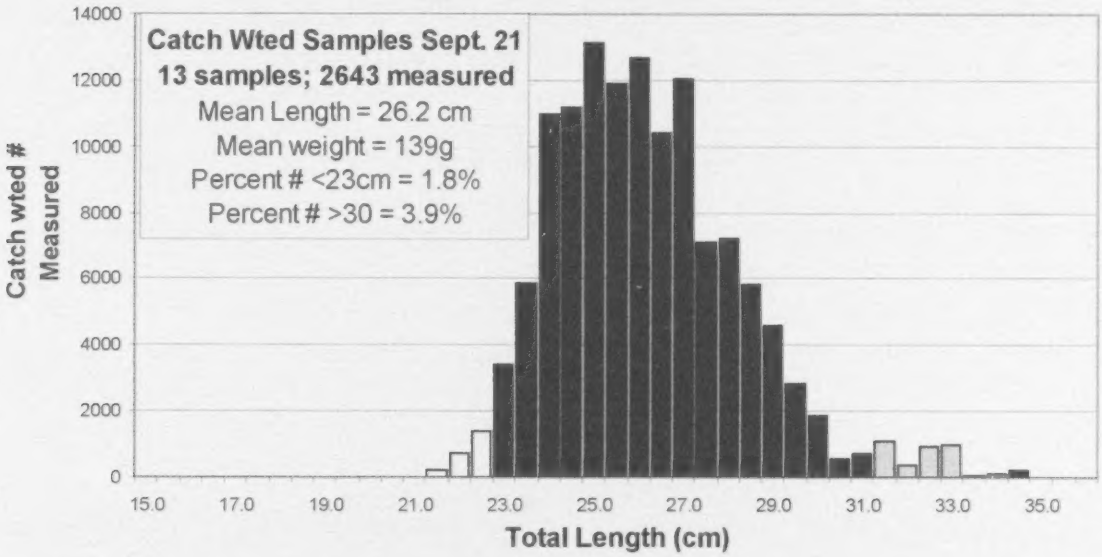

Figure 28A. Length distribution used for calculation of TS for the German Bank acoustic survey (#3) on September 21 2011, from sampling on September 21, with proportions <23cm and >30cm shown as white and grey bars.

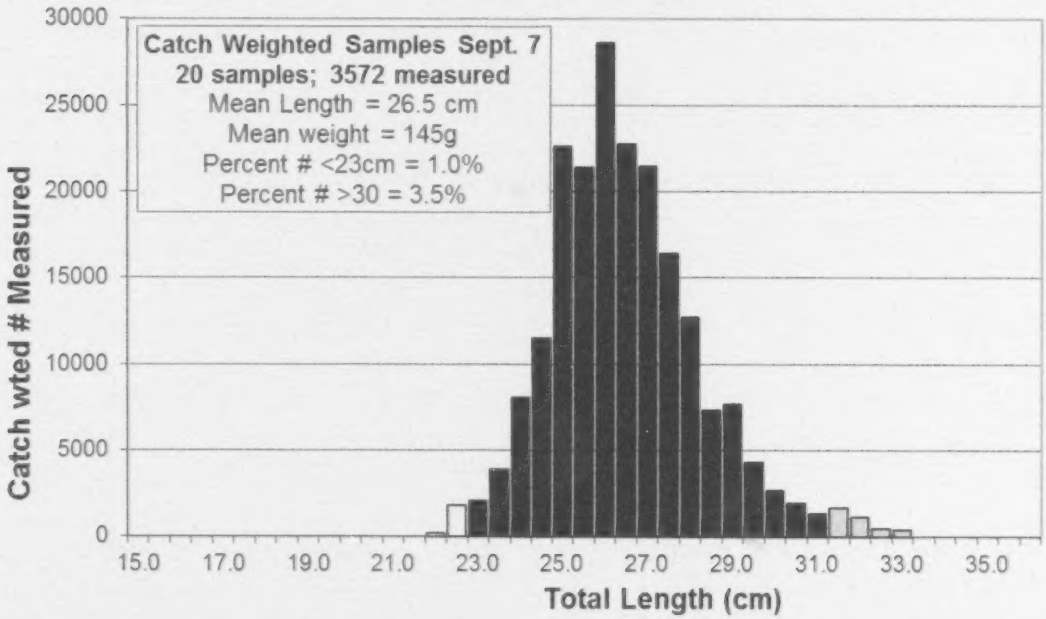

Figure 28B. Length distribution used for calculation of TS for the German Bank acoustic survey (#3) on September 9, 2012, from sampling on September 7, with proportions <23cm and >30cm shown as white and grey bars.

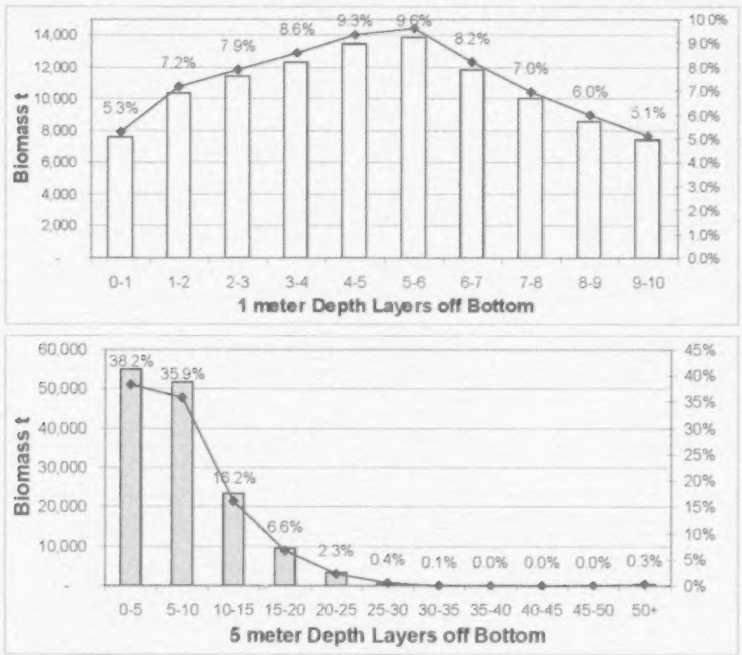

Figure 29A. Distribution of biomass by depth layer from bottom for the German Bank acoustic survey (#3) on September 21, 2011. Biomass is shown as histogram bars and percent as a line for total biomass by 1m layers from 0m to 9m (top panel) and by 5m layers from bottom to surface (bottom panel).

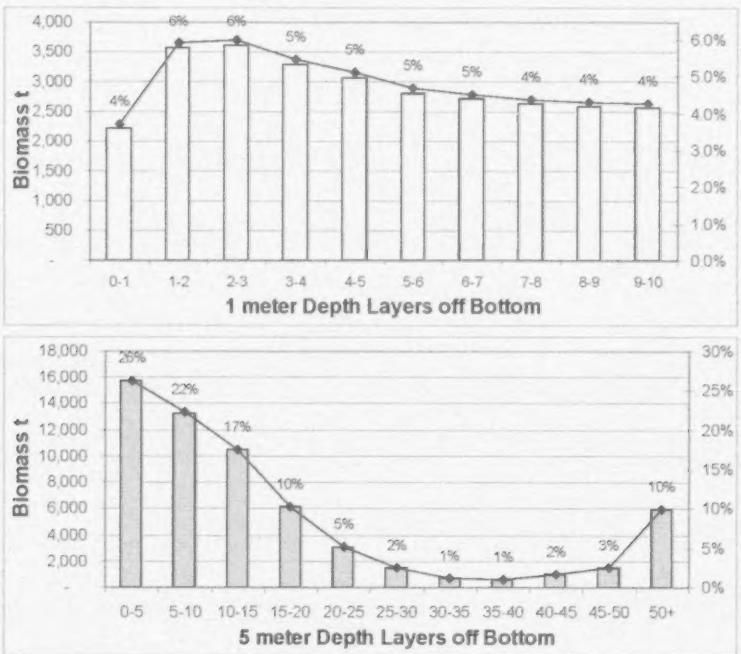

Figure 29B. Distribution of biomass by depth layer from bottom for the German Bank acoustic survey (#3) on September 9, 2012. Biomass is shown as histogram bars and percent as a line for total biomass by 1m layers from 0m to 9m (top panel) and by 5m layers from bottom to surface (bottom panel).

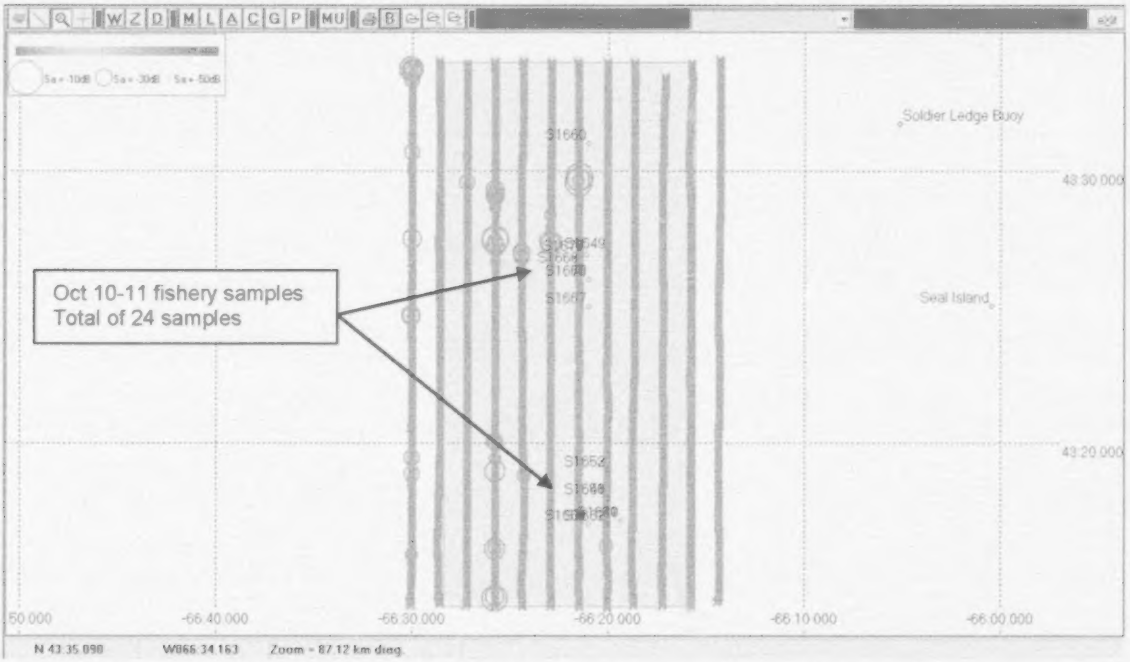

Figure 30A. German Bank acoustic survey (#4) on October 10, 2011, showing the main survey box (highlighted area) and transects with backscatter (Sa) along with the locations of fishery samples used for the TS.

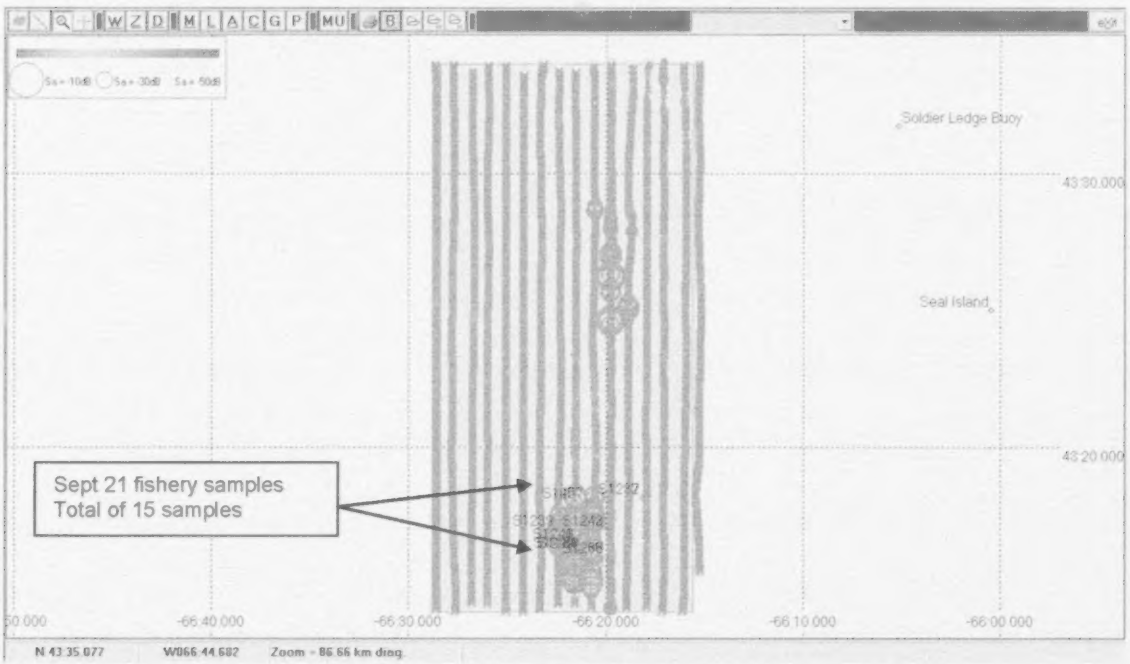

Figure 30B. German Bank acoustic survey (#4) on September 22, 2012, showing the main survey box (highlighted area) and transects with backscatter (Sa) along with the locations of fishery samples used for the TS.

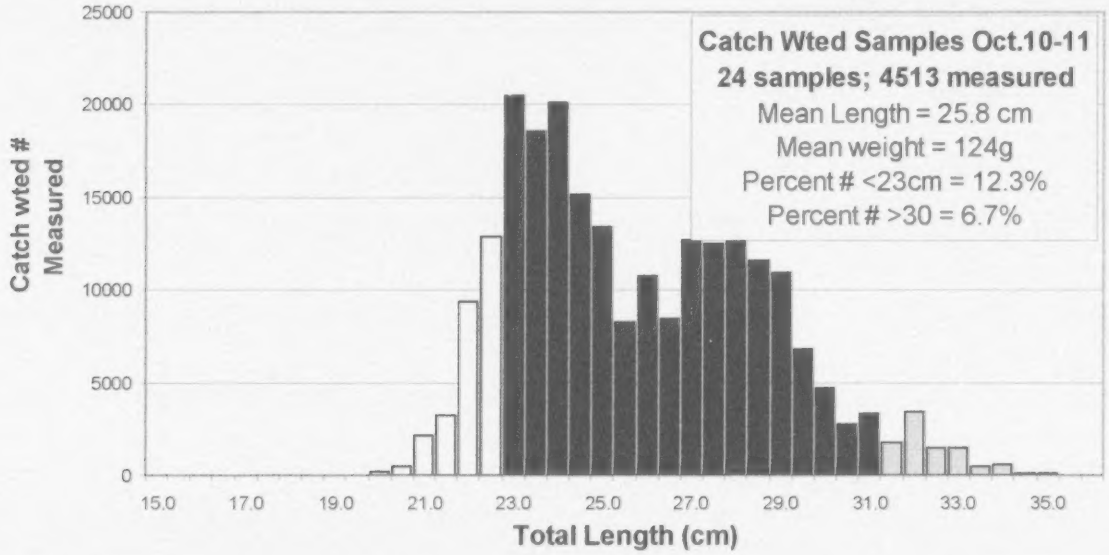

Figure 31A. Length distribution used for calculation of TS for the German Bank acoustic survey (#4) on October 10, 2011, from sampling on October 10-11, with proportions <23cm and >30cm shown as white and grey bars.

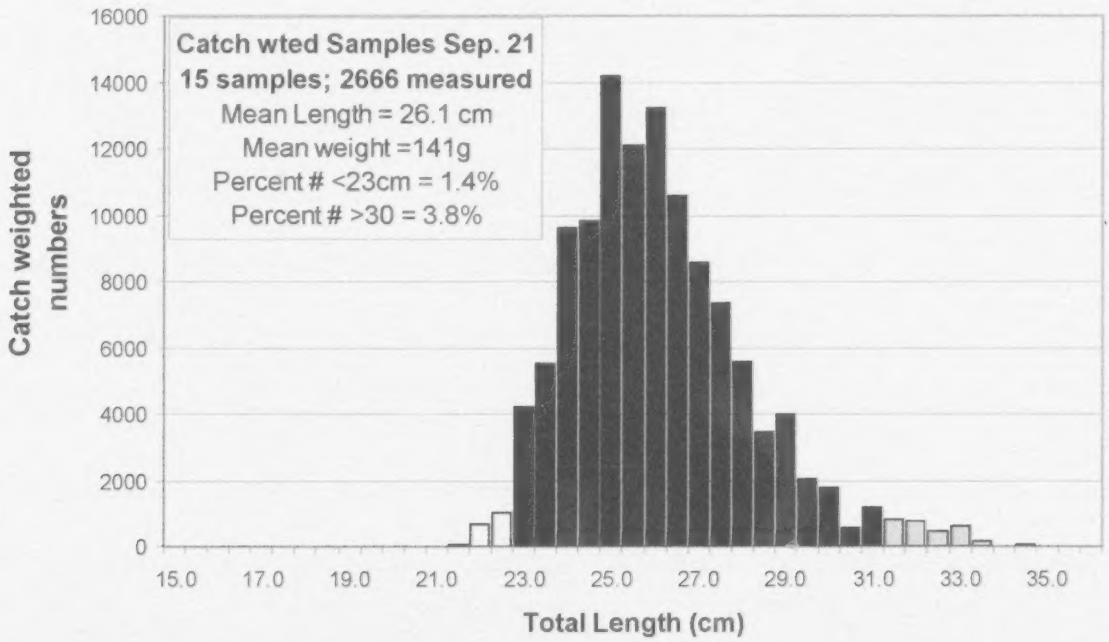

Figure 31B. Length distribution used for calculation of TS for the German Bank acoustic survey (#4) on September 22, 2012, from sampling on September 21, with proportions <23cm and >30cm shown as white and grey bars.

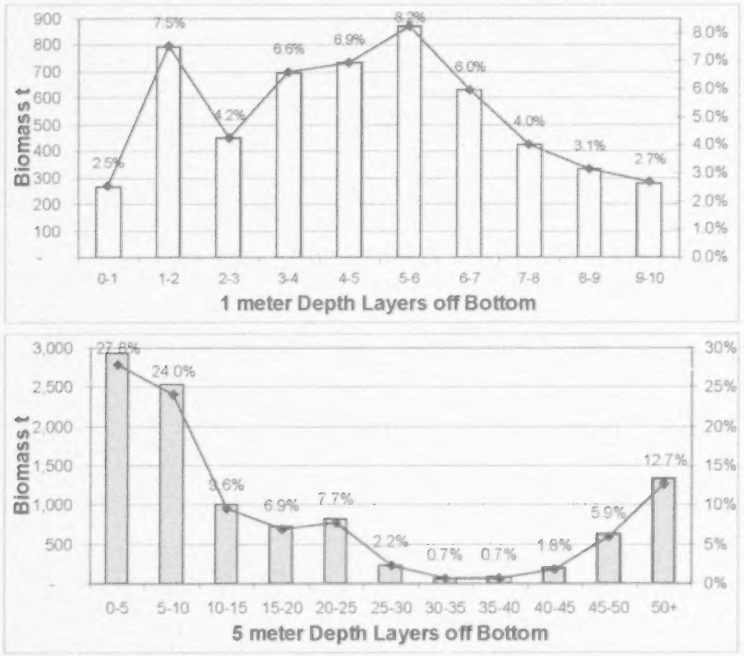

Figure 32A. Distribution of biomass by depth layer from bottom for the German Bank acoustic survey (#4) on October 10, 2011. Biomass is shown as histogram bars and percent as a line for total biomass by 1m layers from 0m to 9m (top panel) and by 5m layers from bottom to surface (bottom panel).

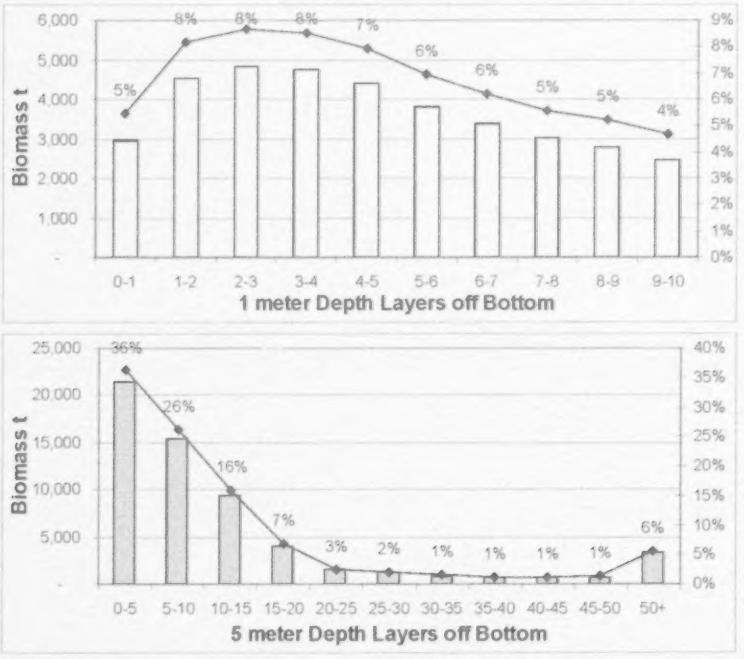

Figure 32B. Distribution of biomass by depth layer from bottom for the German Bank acoustic survey (#4) on September 22, 2012. Biomass is shown as histogram bars and percent as a line for total biomass by 1m layers from 0m to 9m (top panel) and by 5m layers from bottom to surface (bottom panel).

Figure 33A. German Bank acoustic survey (#5) on October 23, 2011, showing the main survey box (highlighted area) and transects with backscatter (Sa). Note that this survey excluded due to lack of samples.

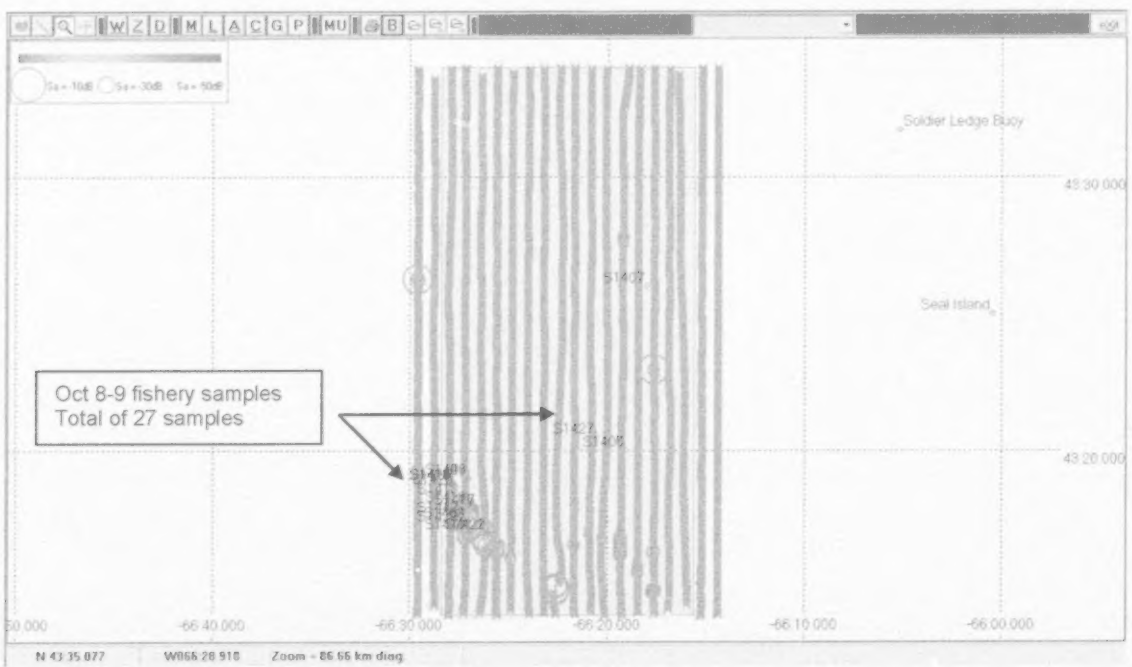

Figure 33B. German Bank acoustic survey (#5) on October 7, 2012, showing the main survey box (highlighted area) and transects with backscatter (Sa) along with the locations of fishery samples used for the TS.

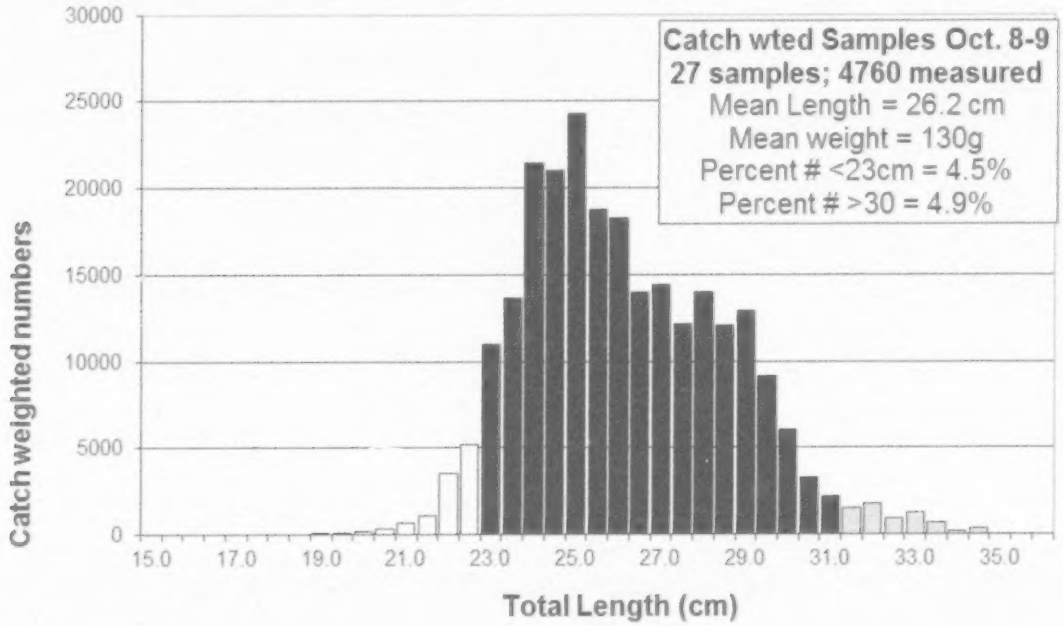

Figure 34. Length distribution used for calculation of TS for the German Bank acoustic survey (#5) on October 7, 2012, from sampling on October 8-9, with proportions <23cm and >30cm shown as white and grey bars.

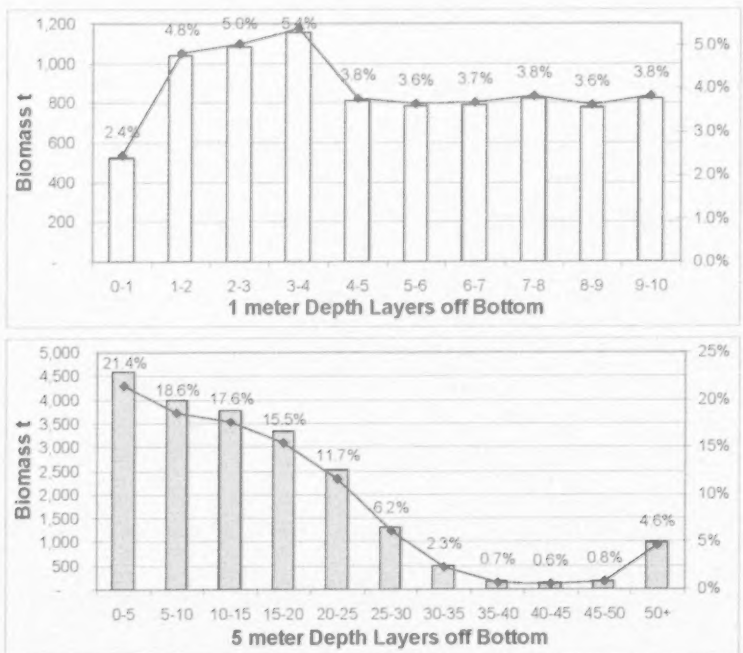

Figure 35. Distribution of biomass by depth layer from bottom for the German Bank acoustic survey (#5) on October 7, 2012. Biomass is shown as histogram bars and percent as a line for total biomass by 1m layers from 0m to 9m (top panel) and by 5m layers from bottom to surface (bottom panel).

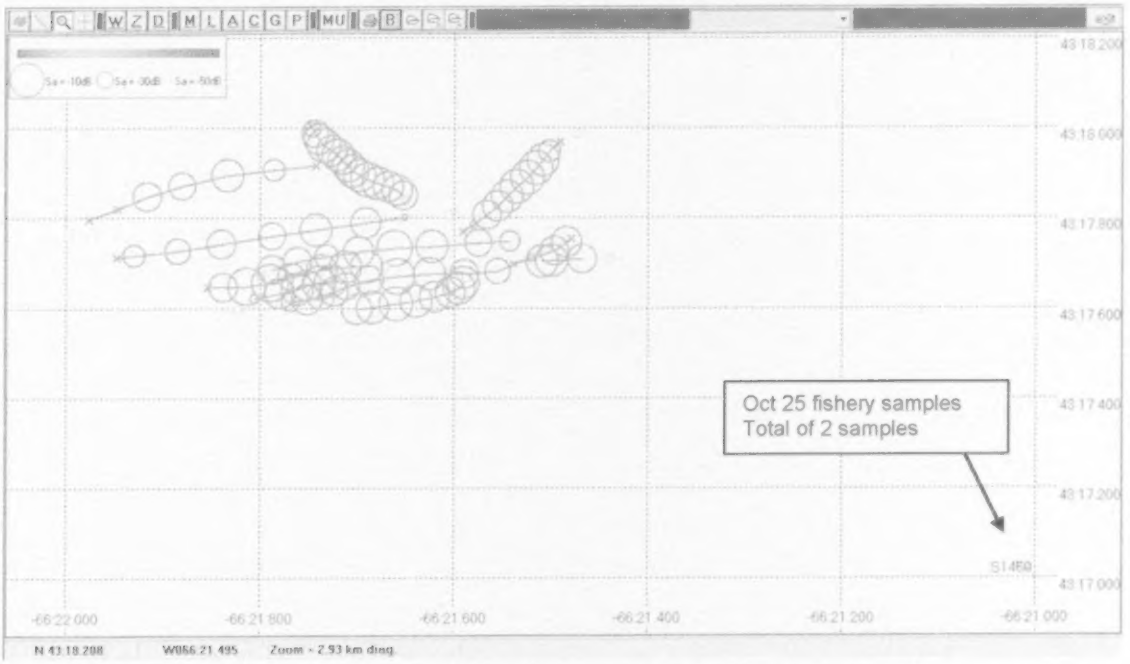

Figure 36. German Bank acoustic survey (#6) on October 24, 2012, showing transects with backscatter (Sa). This entire survey was within the survey box (not shown) along with locations of the two fishery samples (bottom right corner) used for the TS.

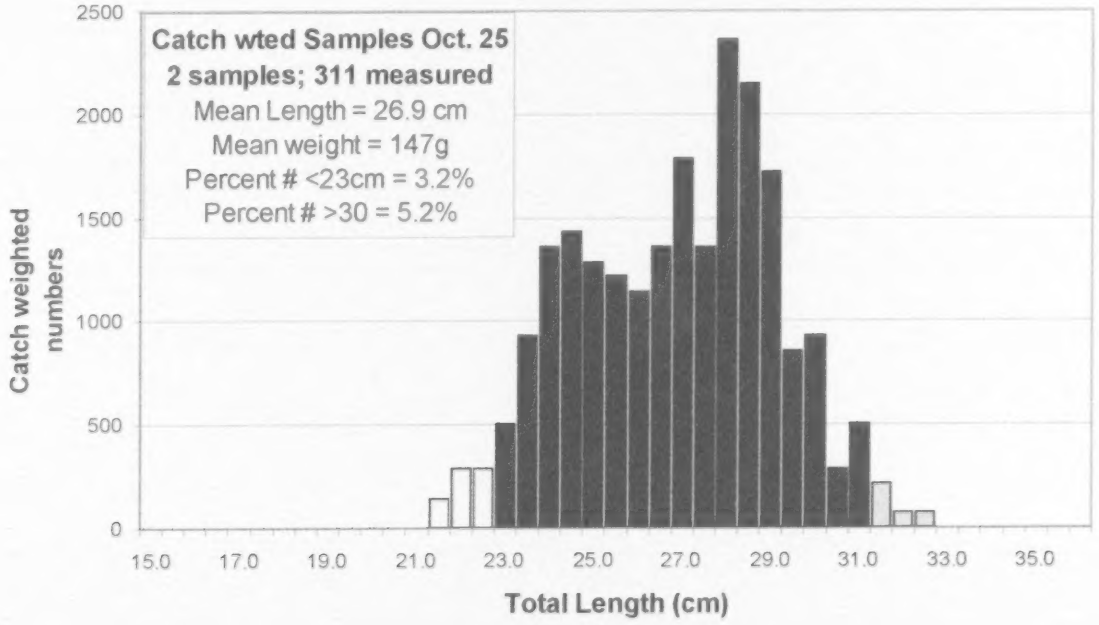

Figure 37. Length distribution used for calculation of TS for the German Bank acoustic survey (#6) on October 24, 2012, from sampling on October 25, with proportions <23cm and >30cm shown as white and grey bars.

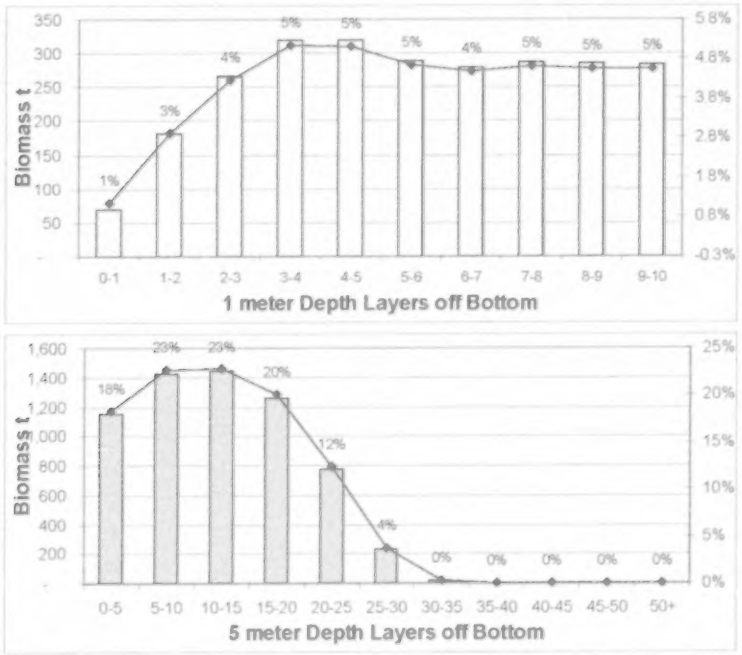

Figure 38. Distribution of biomass by depth layer from bottom for the German Bank acoustic survey (#6) on October 24, 2012. Biomass is shown as histogram bars and percent as a line for total biomass by 1m layers from 0m to 9m (top panel) and by 5m layers from bottom to surface (bottom panel).

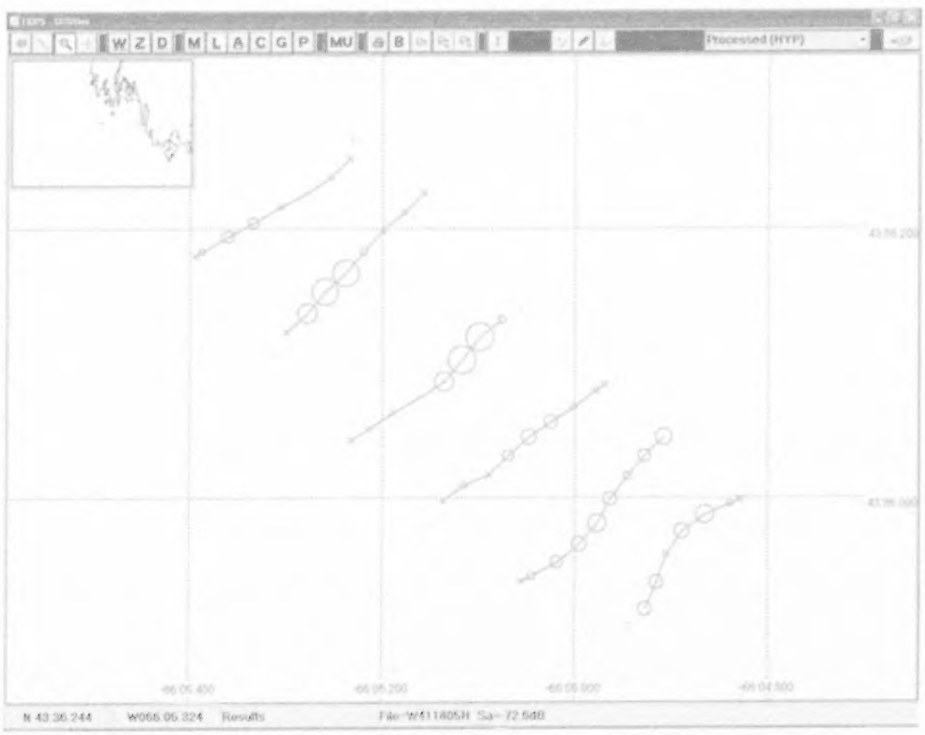

Figure 39. Spectacle Buoy area acoustic survey on May 25, 2011, showing tracks conducted by the vessel Wet & Wild.

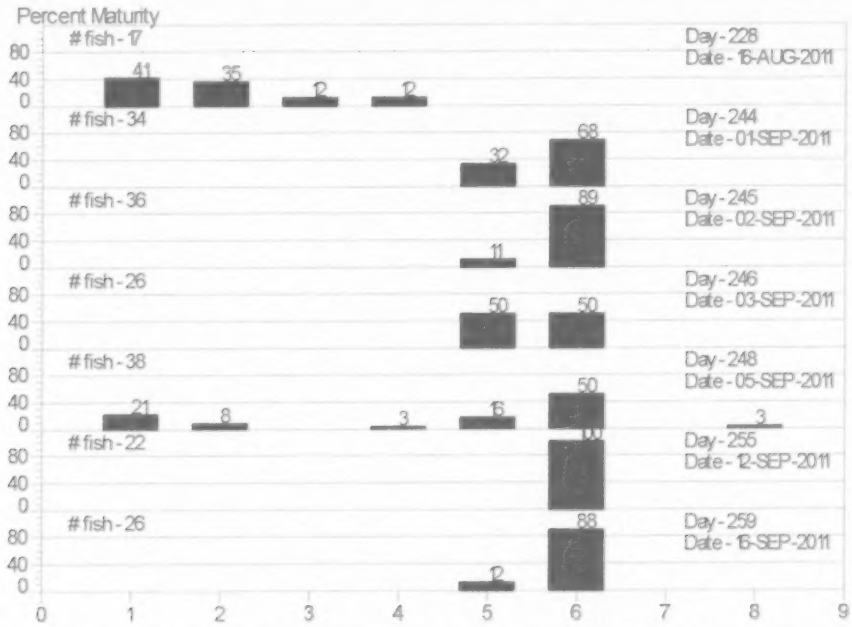

Figure 40A. Herring maturity samples collected from the Trinity Ledge area in 2011. (Staging codes 1-2=immature; 3-4-5=maturing/hard; 6=ripe and running; 7=spent; 8=recovering).

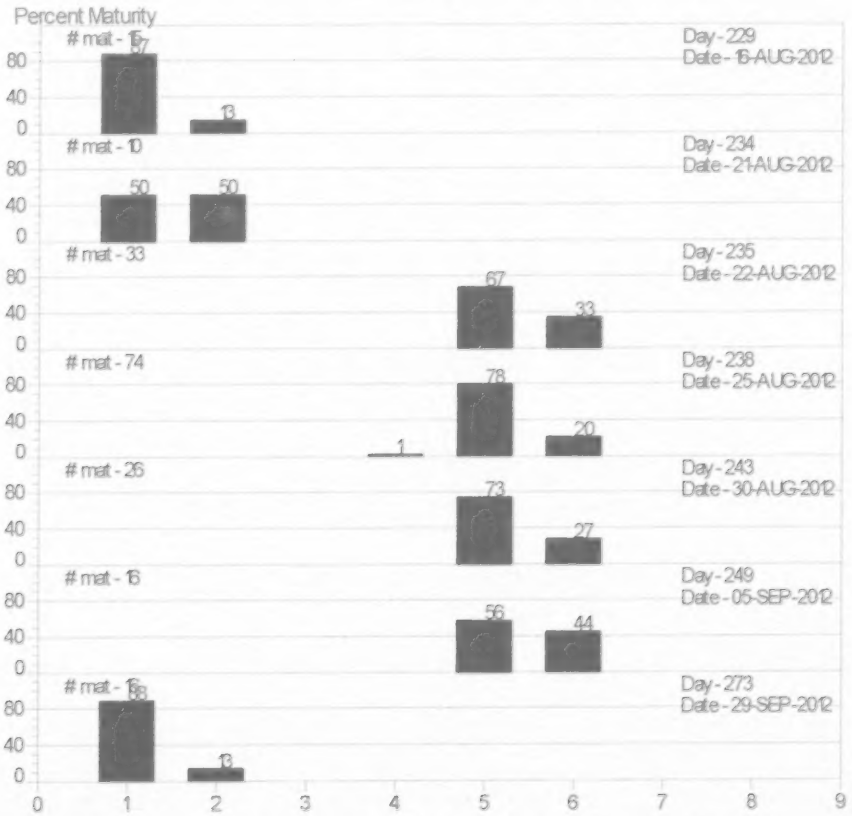

Figure 40B. Herring maturity samples collected from the Trinity Ledge area in 2012. (Staging codes 1-2=immature; 3-4-5=maturing/hard; 6=ripe and running; 7=spent; 8=recovering).

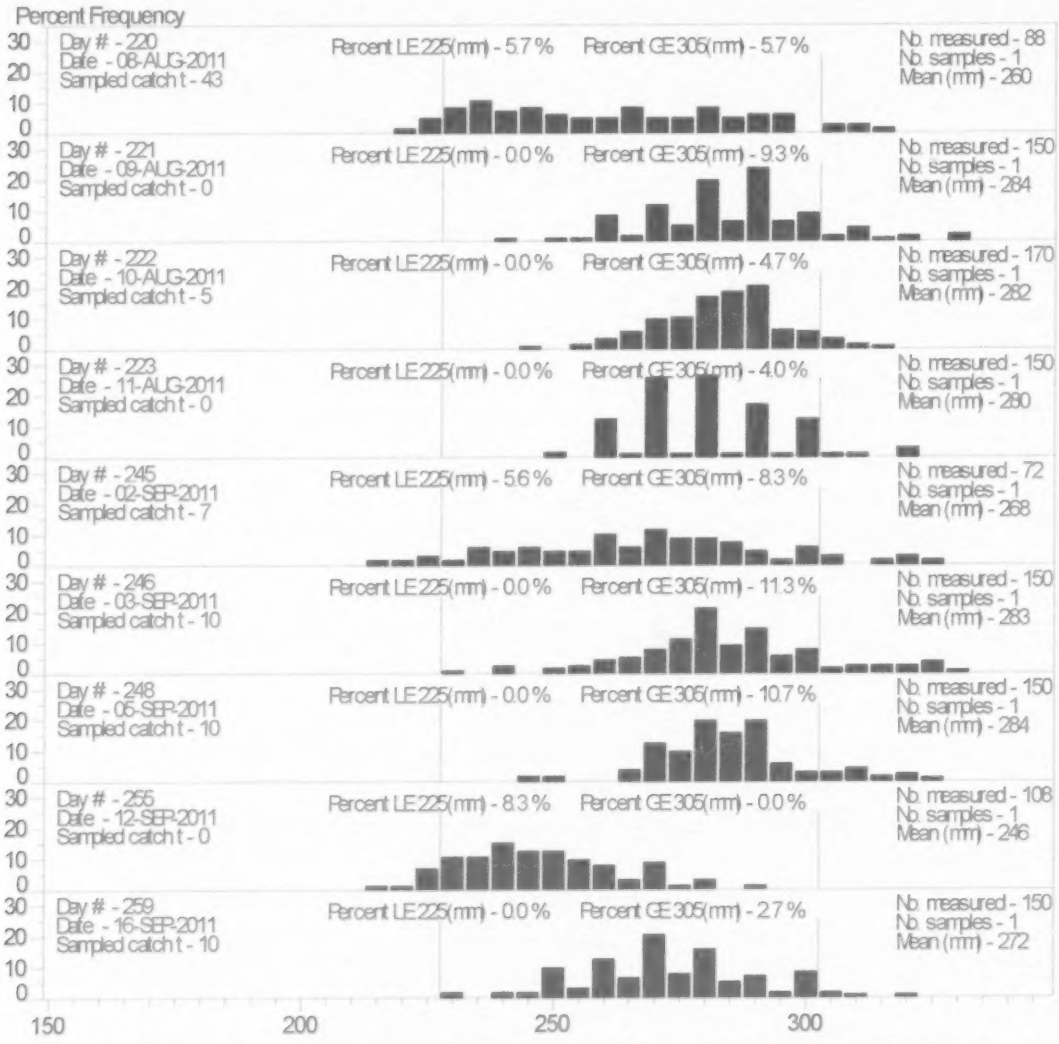

Figure 41A. Daily herring length frequency samples collected from the Trinity Ledge gillnet fishery in 2011, with proportions <23cm and >30cm.

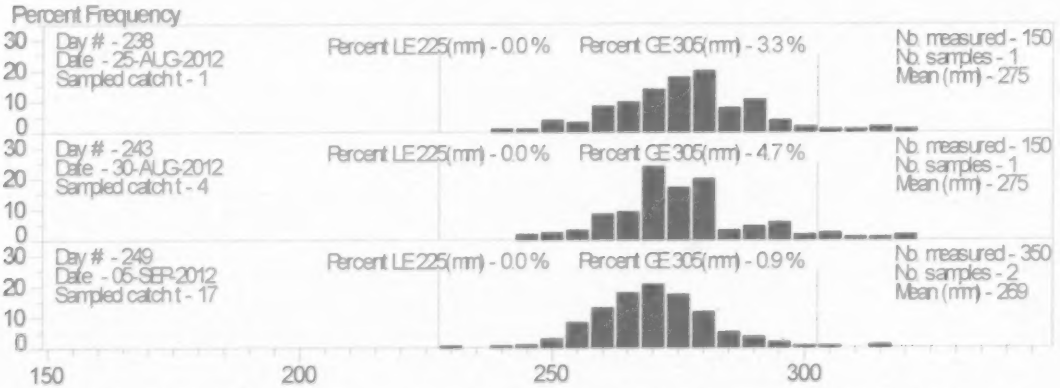

Figure 41B. Daily herring length frequency samples collected from the Trinity Ledge gillnet fishery in 2012, with proportions <23cm and >30cm.

Figure 42A. Trinity Ledge area herring acoustic survey (#1) on August 7, 2011, showing tracks conducted by the vessel Wet & Wild. Multi-panel herring gillnet sample collected on August 8 used for TS (see Figure 46).

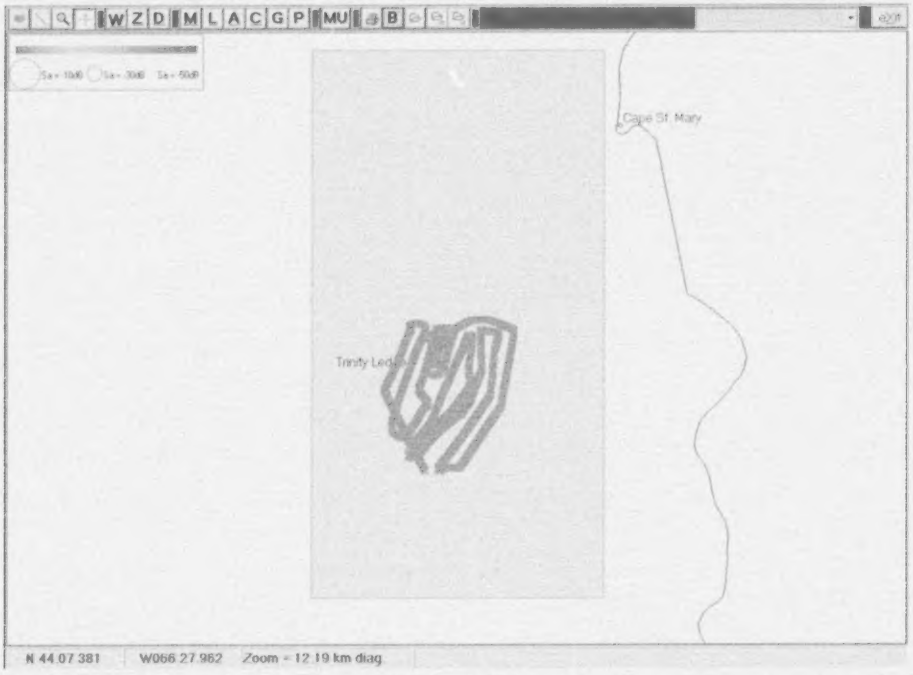

Figure 42B. Trinity Ledge area herring acoustic survey (#1) on August 7, 2012, showing tracks conducted by the vessel Katrina & Kayla. No samples were available. Standard TS used.

Figure 43A. Trinity Ledge area herring acoustic survey (#2) on August 31, 2011, showing tracks conducted by the vessel Wet & Wild. Multi-panel herring gillnet sample collected on September 2 used for TS (see Figure 47).

Figure 43B. Trinity Ledge area herring acoustic survey (#2) on August 23, 2012, showing tracks conducted by the vessel Katrina & Kayla. No samples were available. Standard TS used.

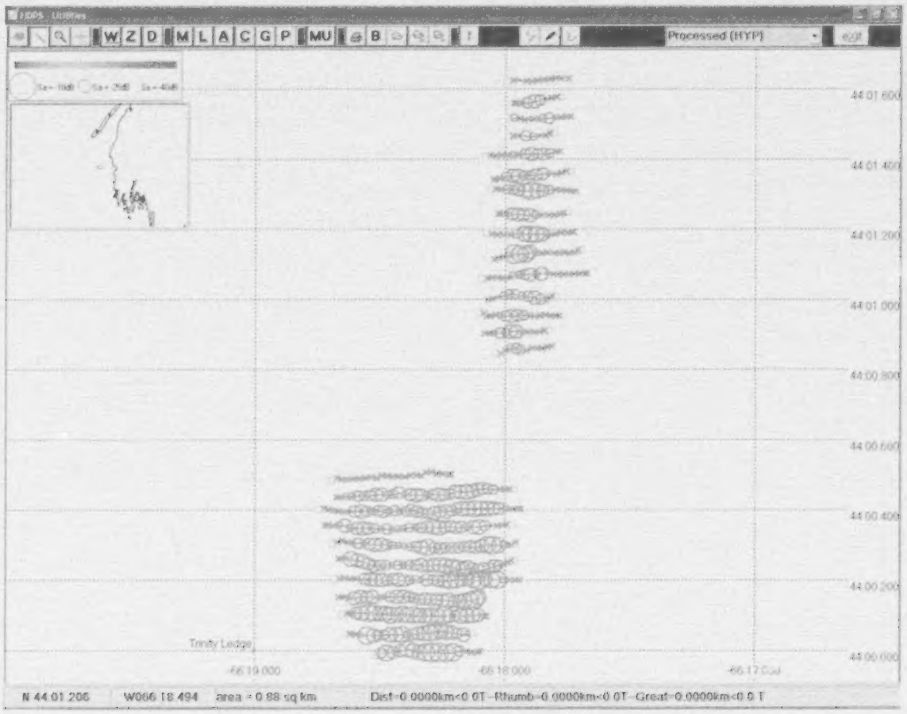

Figure 44A. Trinity Ledge area herring acoustic survey (#3) on September 12, 2011, showing tracks conducted by the vessel Wet & Wild. Multi-panel herring gillnet sample collected on September 12 used for TS (see Figure 48).

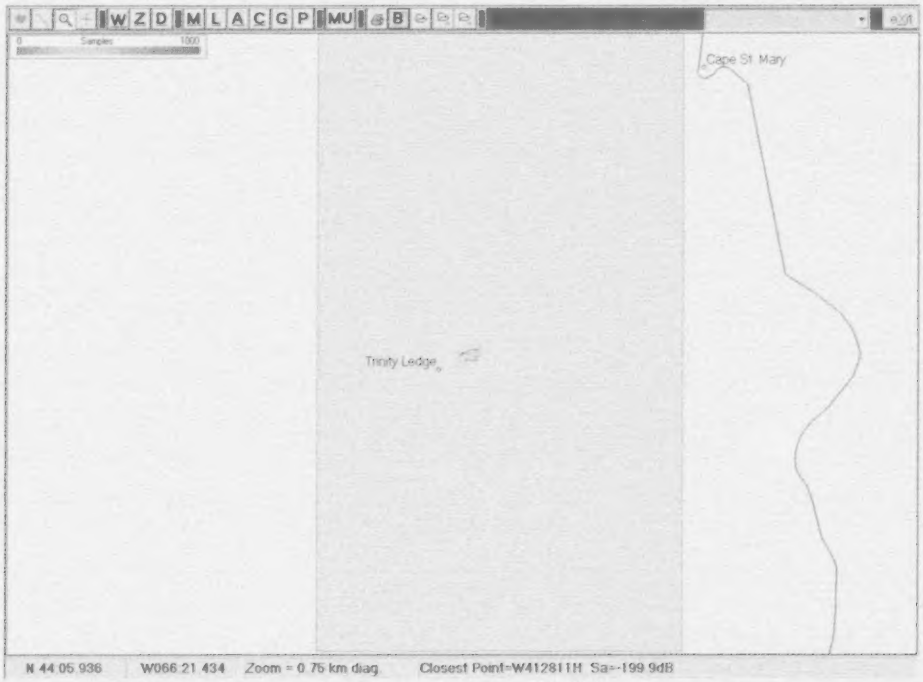

Figure 44B. Trinity Ledge area herring acoustic survey (#3) on September 3, 2012, showing tracks conducted by the vessel Katrina & Kayla. No samples were available. Standard TS used.

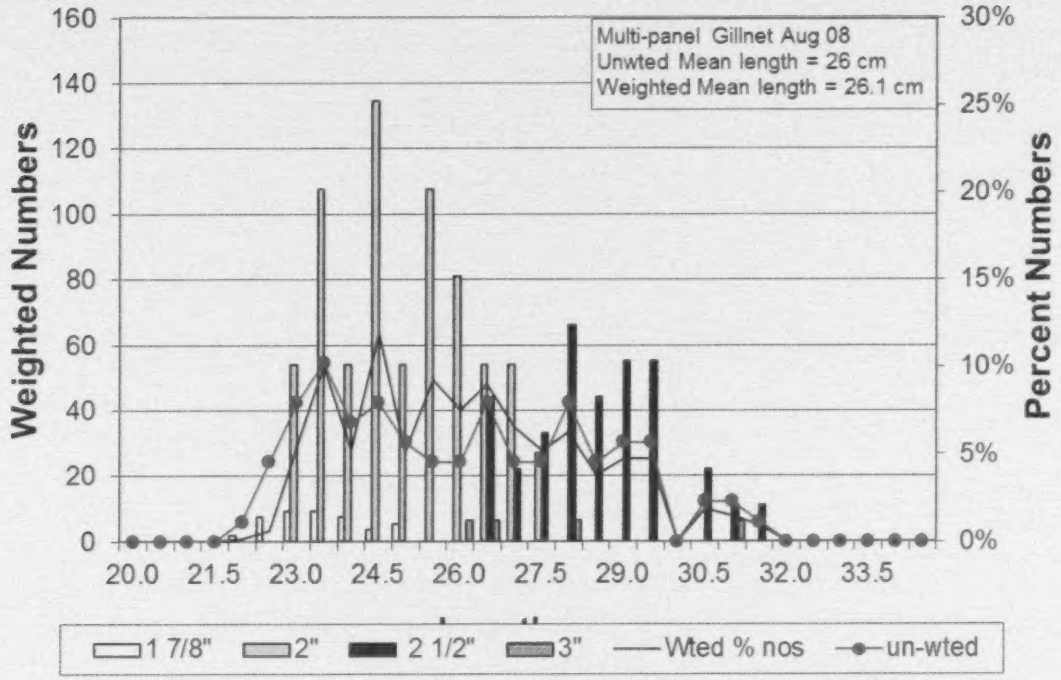

Figure 45. Multi-panel herring gillnet sample collected on August 8, 2011, for Trinity herring gillnet survey (#1) on August 7.

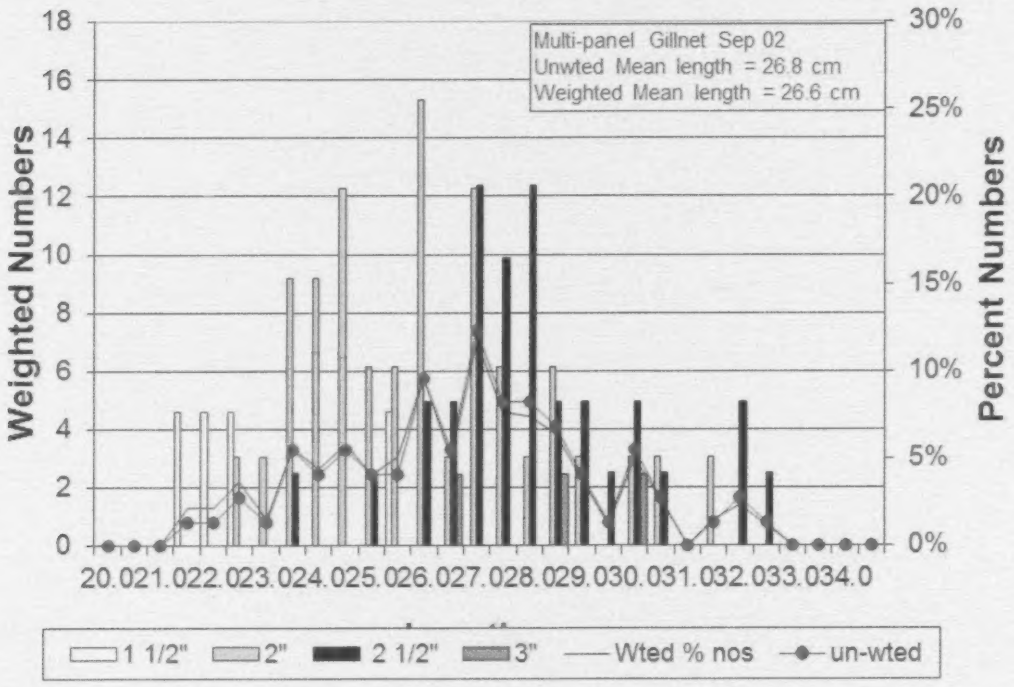

Figure 46. Multi-panel herring gillnet sample collected on August 31, 2011, for Trinity herring gillnet survey (#2) on September 2.

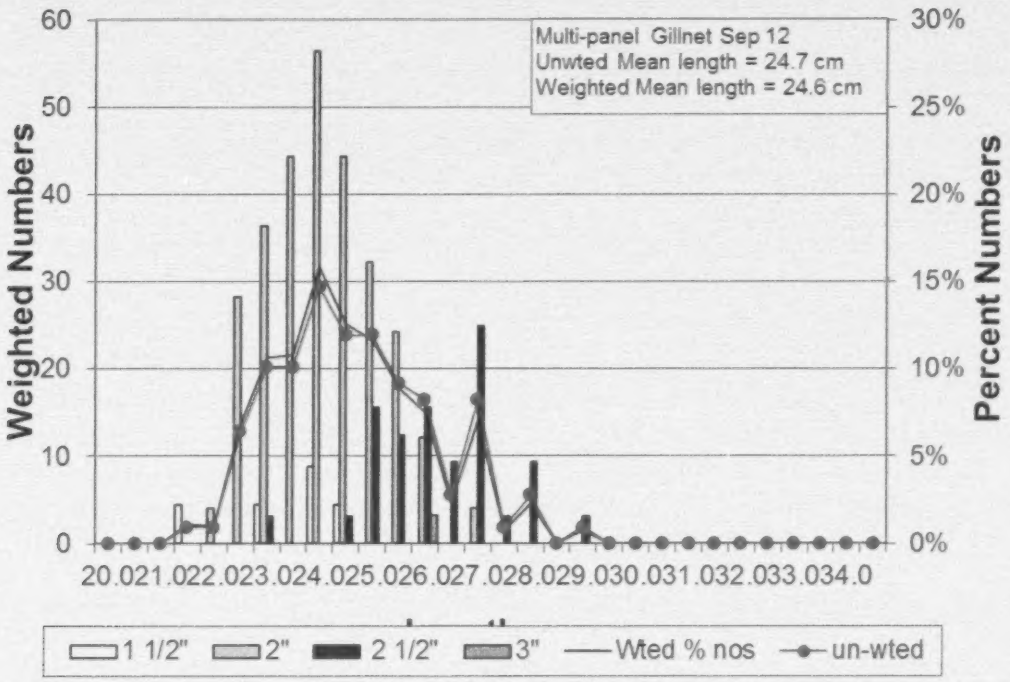

Figure 47. Multi-panel herring gillnet sample collected on September 12, 2011, for Trinity Ledge herring gillnet survey (#3) on September 12.

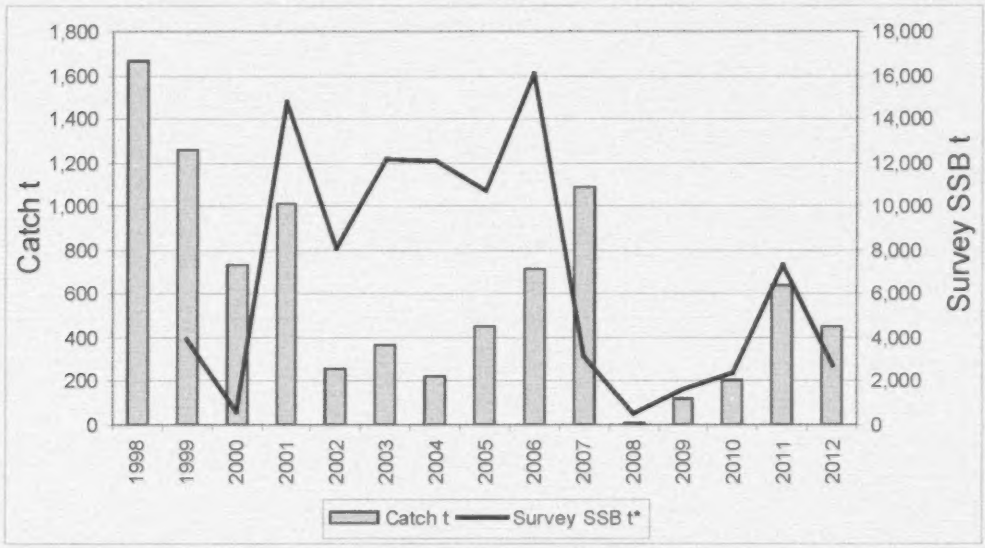

Figure 48. Trinity Ledge herring catches and acoustic survey biomass estimates from 1998-2012. All acoustic estimates were calculated with the CIF except 1999-2002.

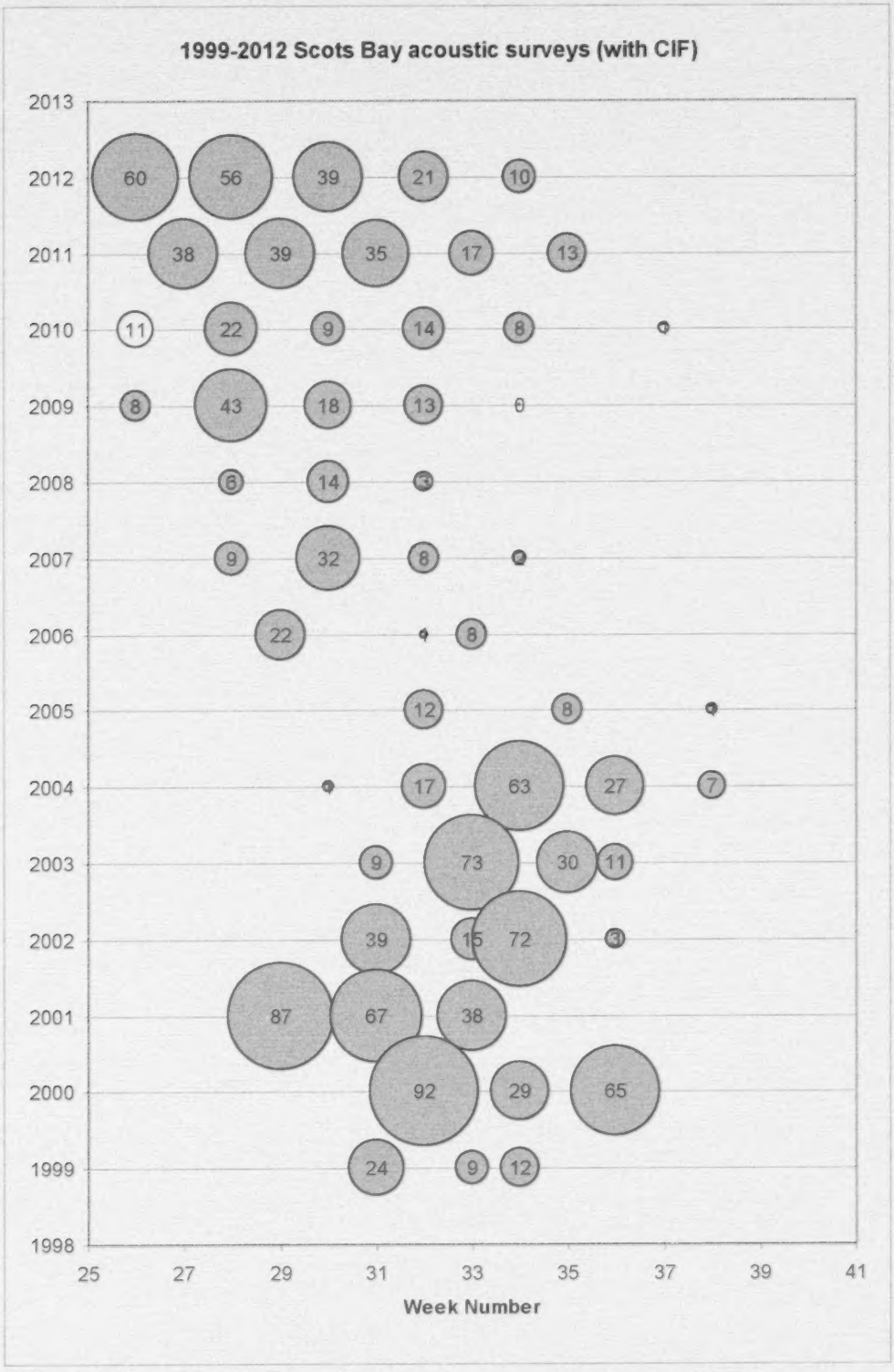

Figure 49. History of Scots Bay herring acoustic surveys from 1999-2012 by week number showing timing with bubble area representing biomass (in thousands) for each survey (calculated with CIF).

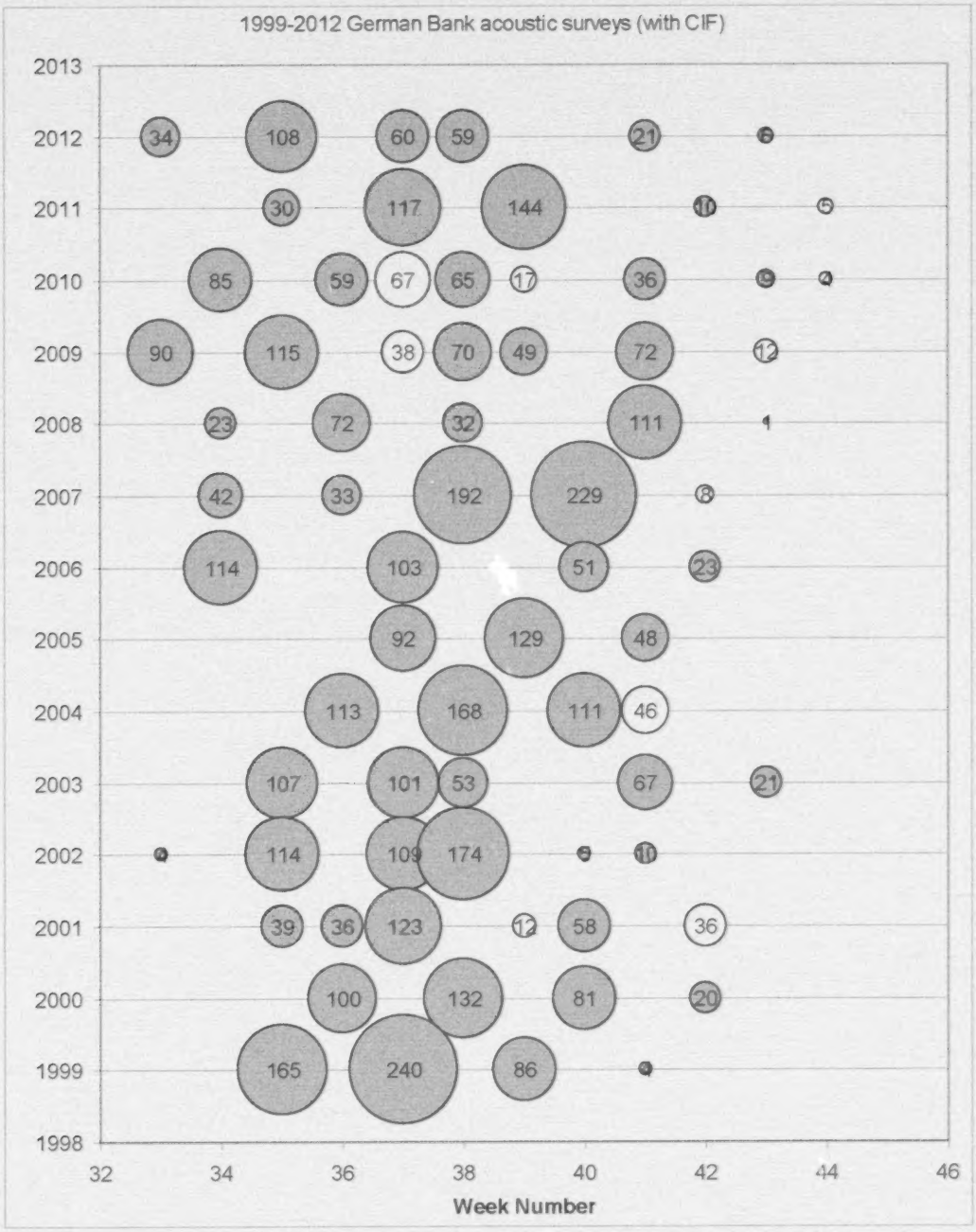

Figure 50. History of German Bank herring acoustic surveys from 1999-2012 by week number showing timing with bubble area representing biomass (in thousands) for each survey (calculated with CIF).

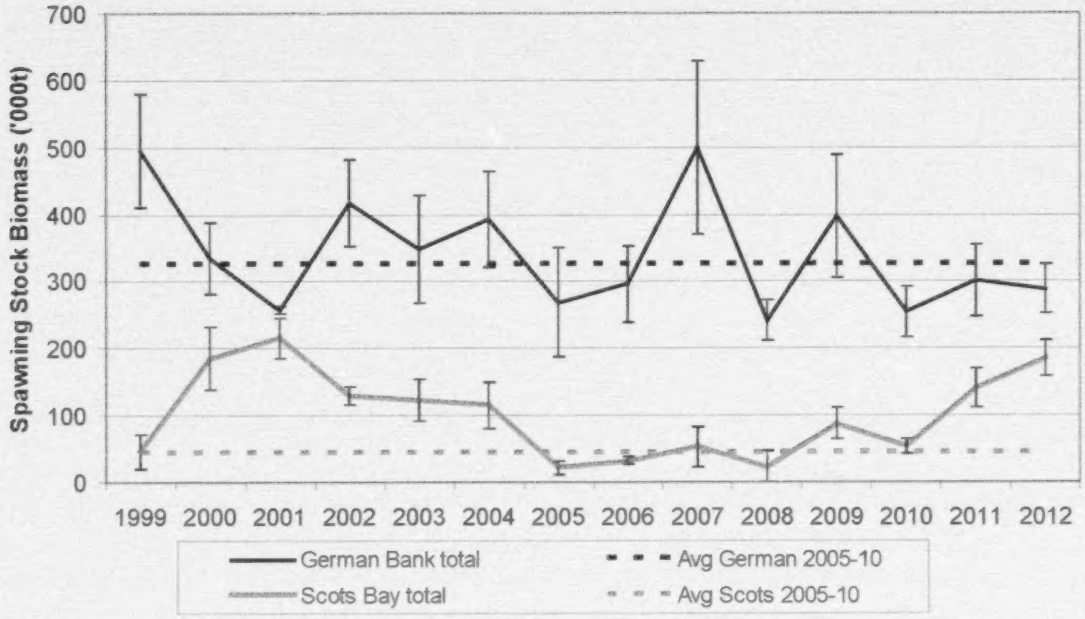

Figure 51. Trends in herring SSB from acoustic surveys areas with 95% confidence intervals in Scots Bay and German Bank areas in relation to the 2005-2010 average. All estimates calculated with CIF.

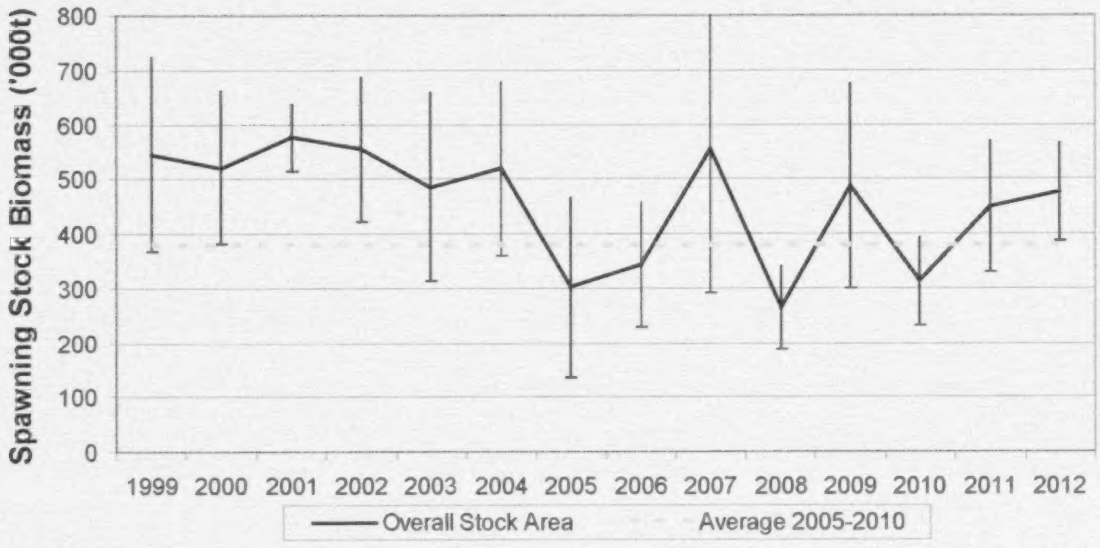

Figure 52. Trends in herring SSB from acoustic surveys for the combined SWNS areas with 95% confidence intervals and the long term average SSB since 1999. All estimates calculated with CIF.

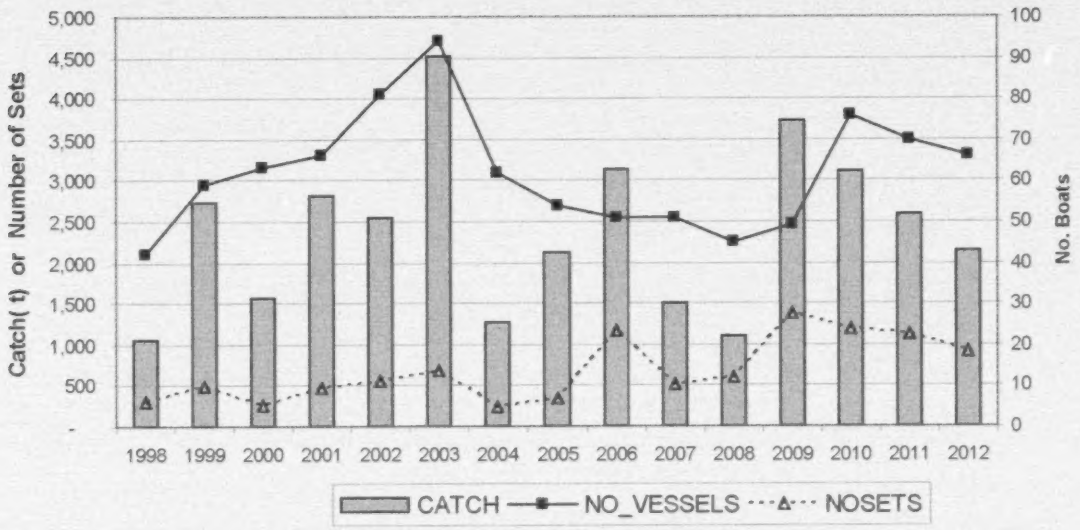

Figure 53. Herring gillnet total catch (tons) and total effort in number of vessels and number of sets for the Little Hope/Port Mouton area for 1998-2012. Data for statistical districts 26-31 inclusive. Note overlap of district 26 with Liverpool area.

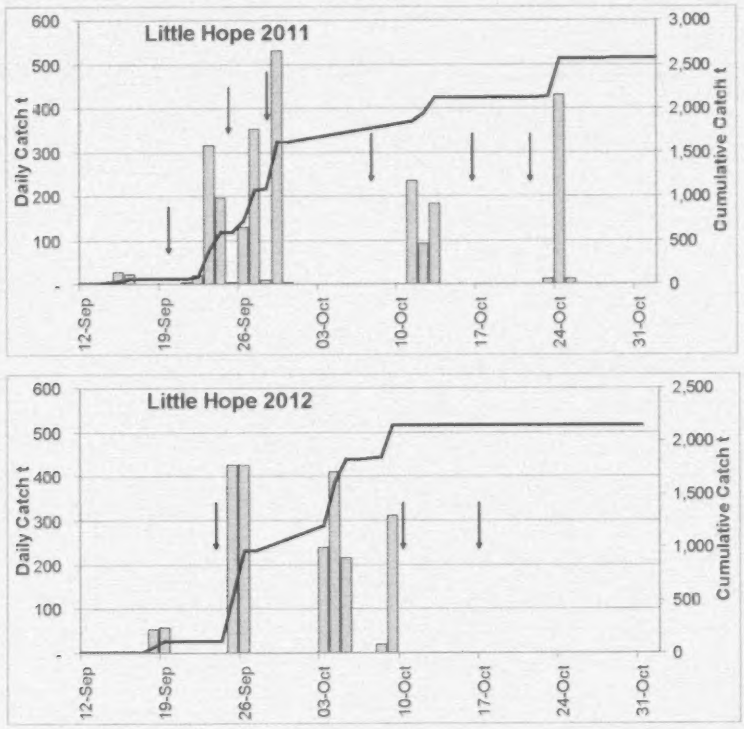

Figure 54. Daily and cumulative catch for 2010 and 2012 Little Hope/Port Mouton herring gillnet fishery. Survey dates are identified with arrows indicating survey timing.

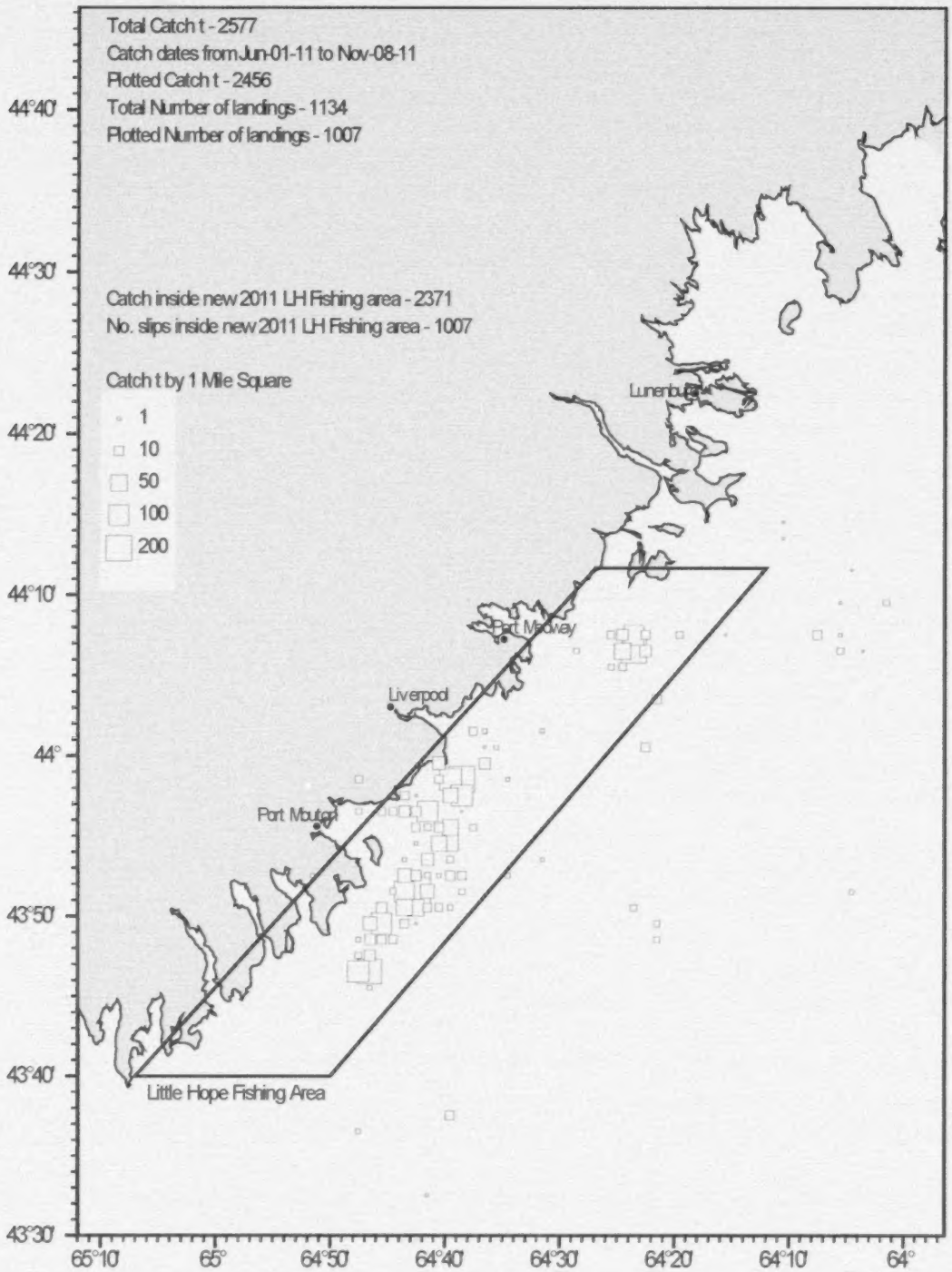

Figure 55A. Fishery herring gillnet catch distribution for the Little Hope/Port Mouton area for 2011.

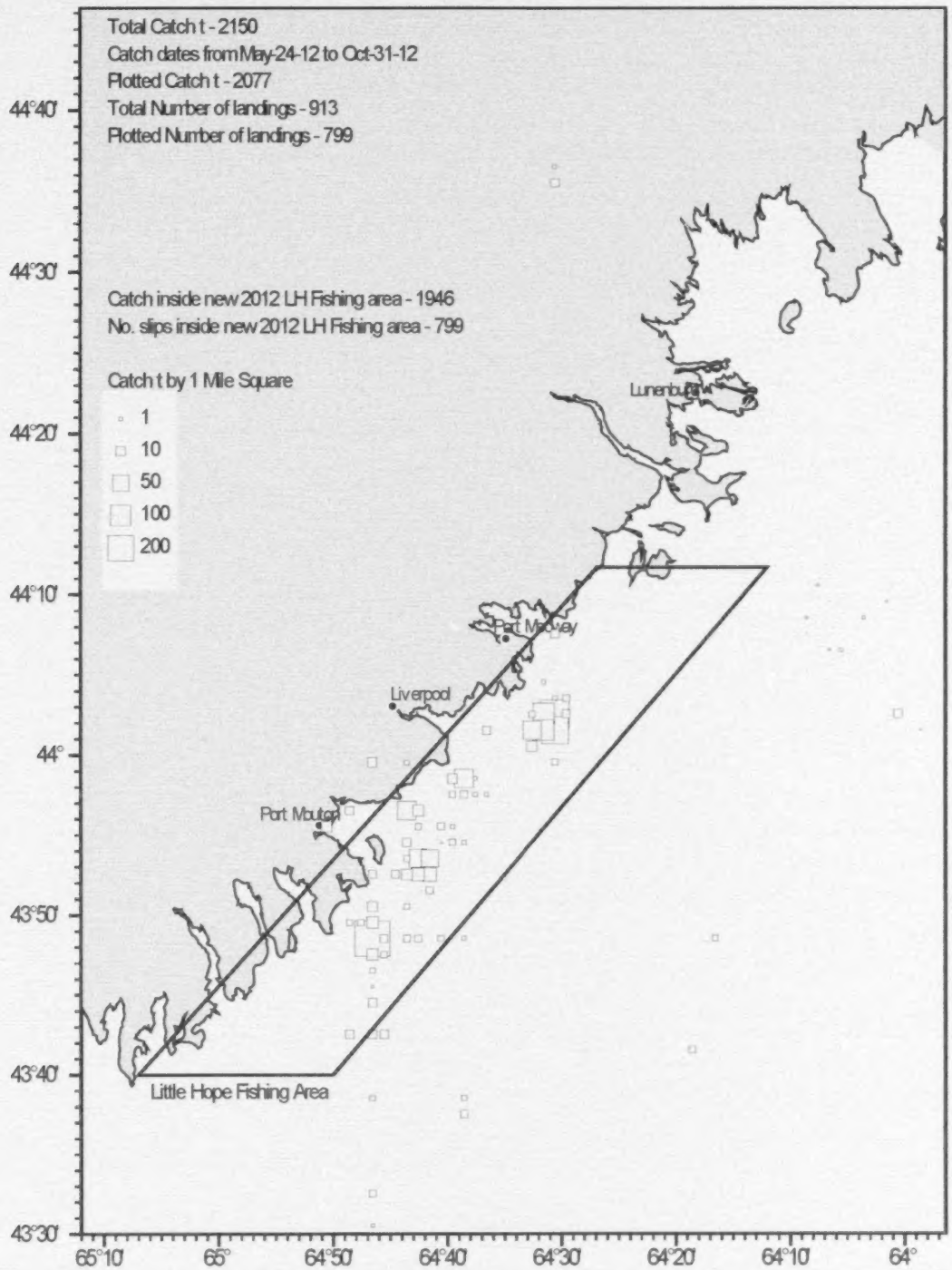

Figure 55B. Fishery herring gillnet catch distribution for the Little Hope/Port Mouton area for 2012.

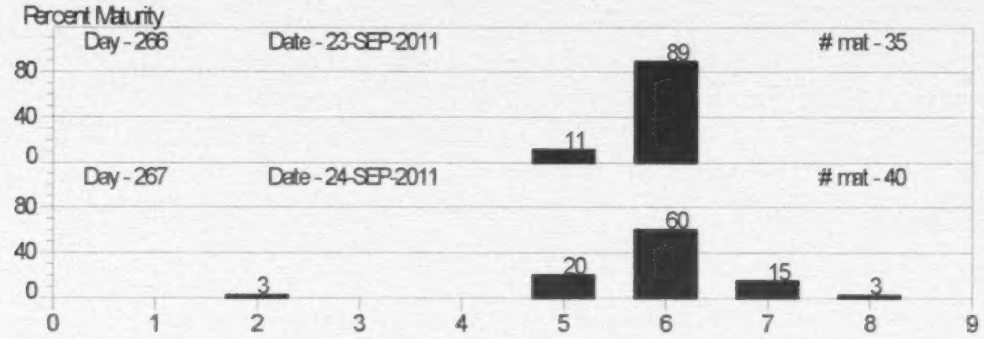

Figure 56A. Port Mouton/Little Hope maturity sampling from gillnet commercial landings for 2011. (Staging codes 1-2=immature; 3-4-5=maturing/hard; 6=ripe and running; 7=spent; 8=recovering).

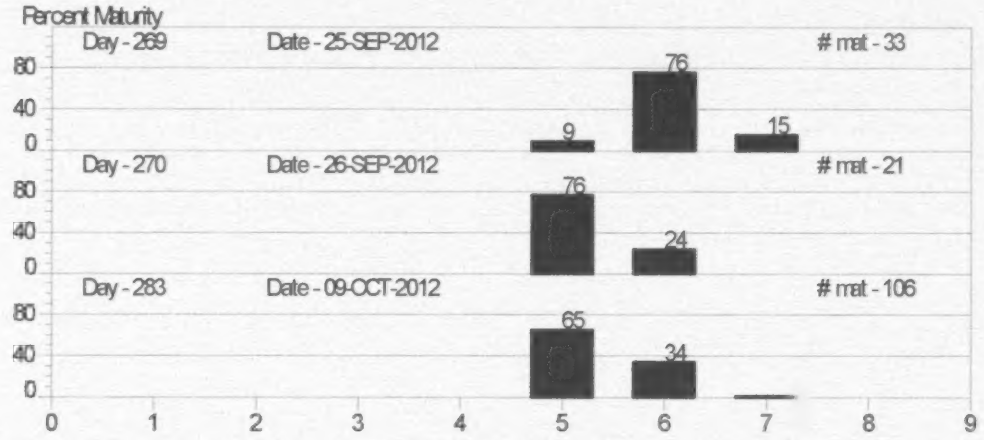

Figure 56B. Port Mouton/Little Hope maturity sampling from gillnet commercial landings for 2012. (Staging codes 1-2=immature; 3-4-5=maturing/hard; 6=ripe and running; 7=spent; 8=recovering).

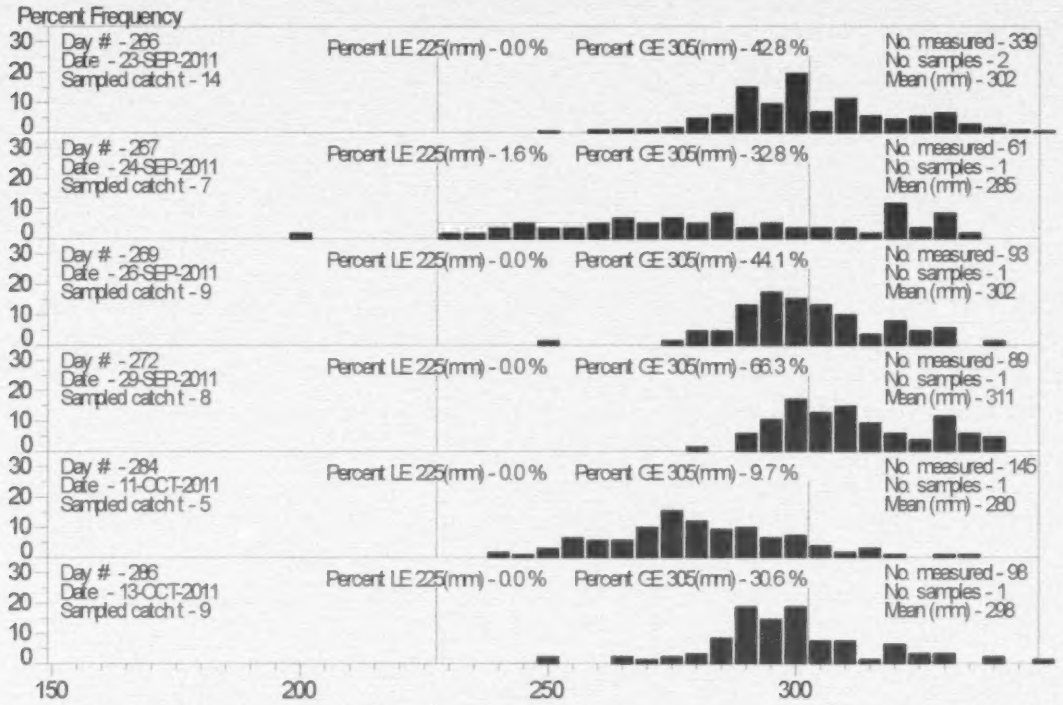

Figure 57A. Port Mouton/Little Hope daily length frequency sampling from gillnet commercial landings from September 15 to October 13, 2011, with proportions <23cm and >30cm.

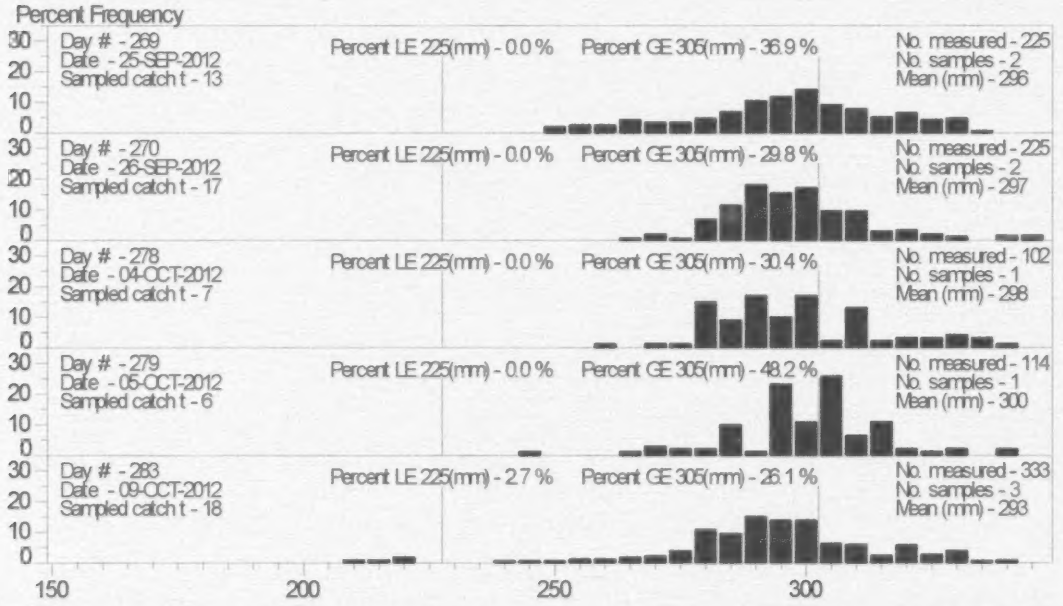

Figure 57B. Port Mouton/Little Hope daily length frequency sampling from gillnet commercial landings from September 15 to October 13, 2012, with proportions <23cm and >30cm.

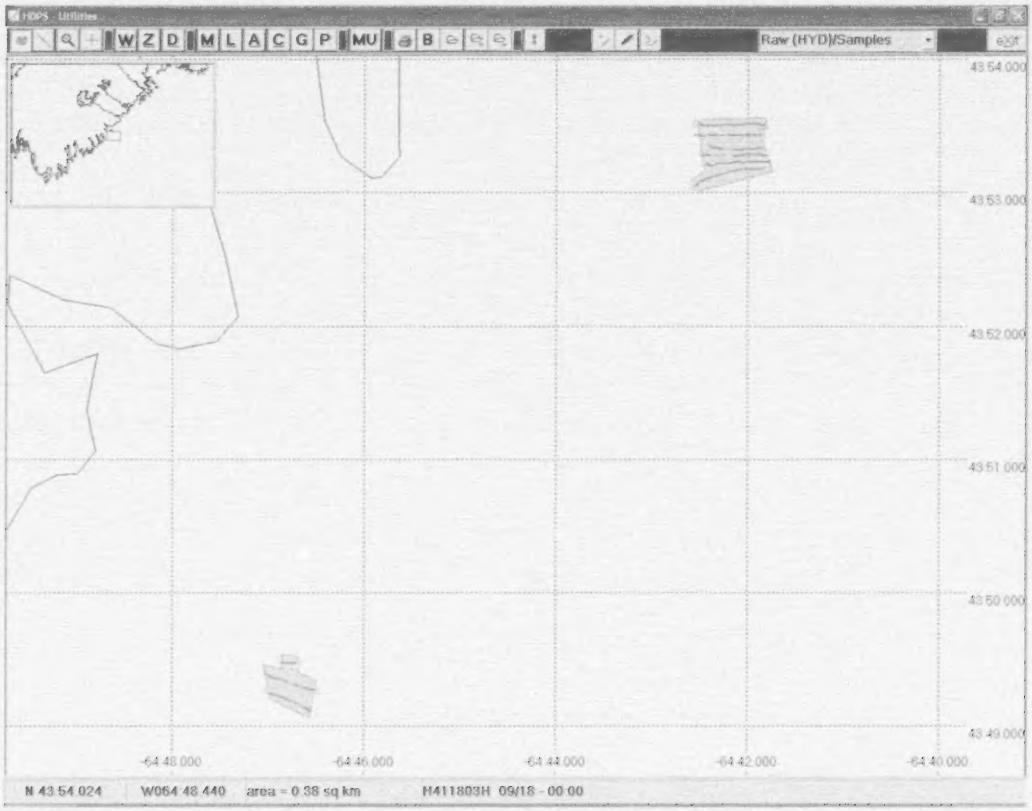

Figure 58A. Little Hope/Port Mouton herring gillnet survey (#1) on September 17, 2011, showing transects for each of the school areas. No multi-panel samples, standard TS used.

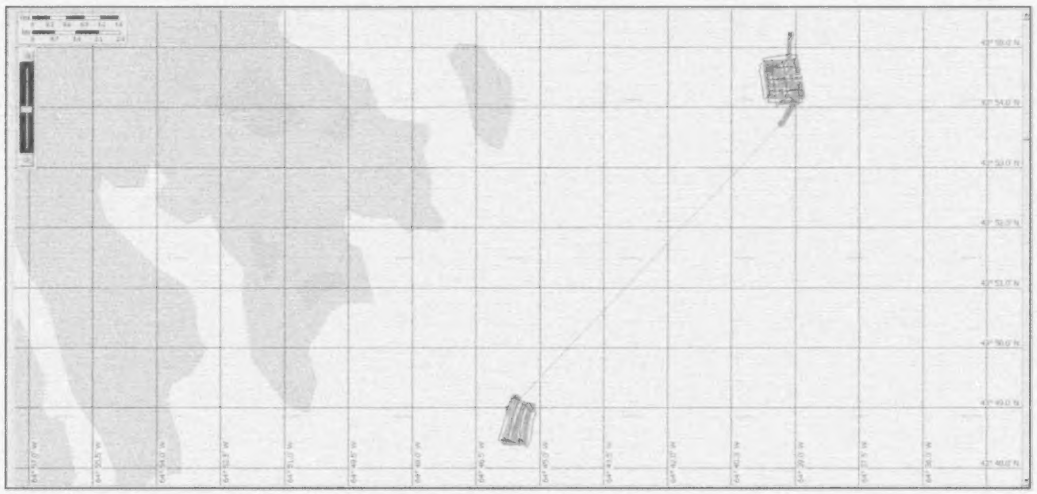

Figure 58B. Little Hope/Port Mouton herring gillnet survey (#1) on September 24, 2012, showing transects for each of the school areas. Two schools were surveyed using the Simrad ES70 (120 kHz) echosounder. Multi-panel herring gillnet sample collected on September 25 (see Figure 60).

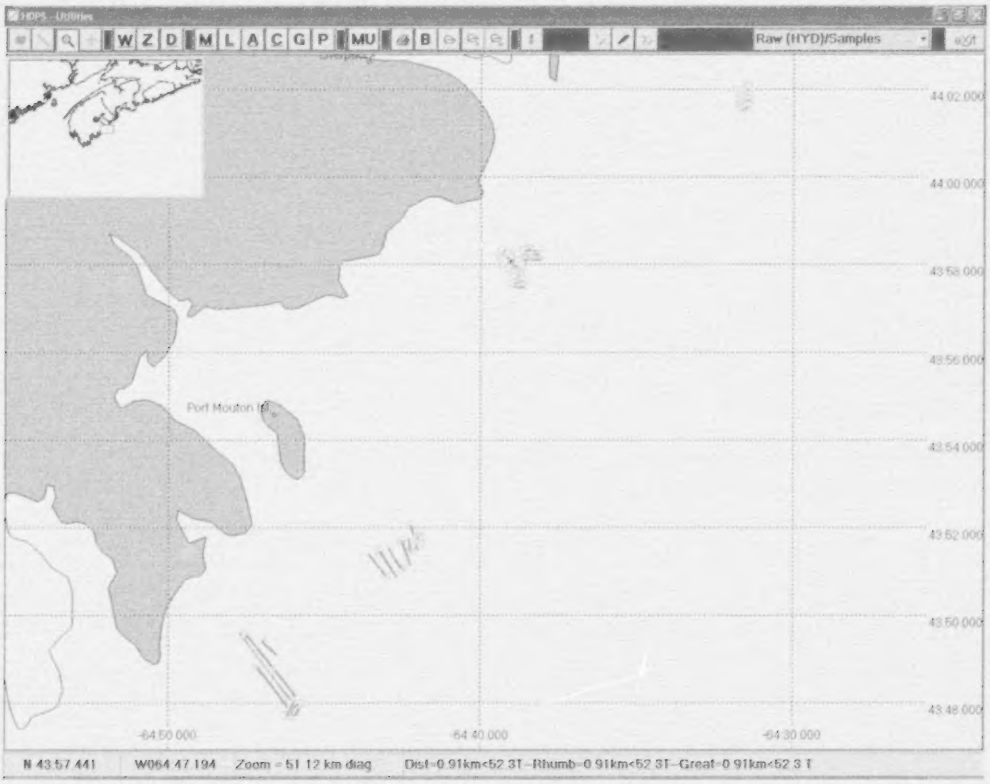

Figure 59A. Little Hope/Port Mouton herring gillnet survey (#2b) on September 27, 2011, showing transects for each of the school areas. Multi-panel herring gillnet sample collected on September 24 (see Figure 61A).

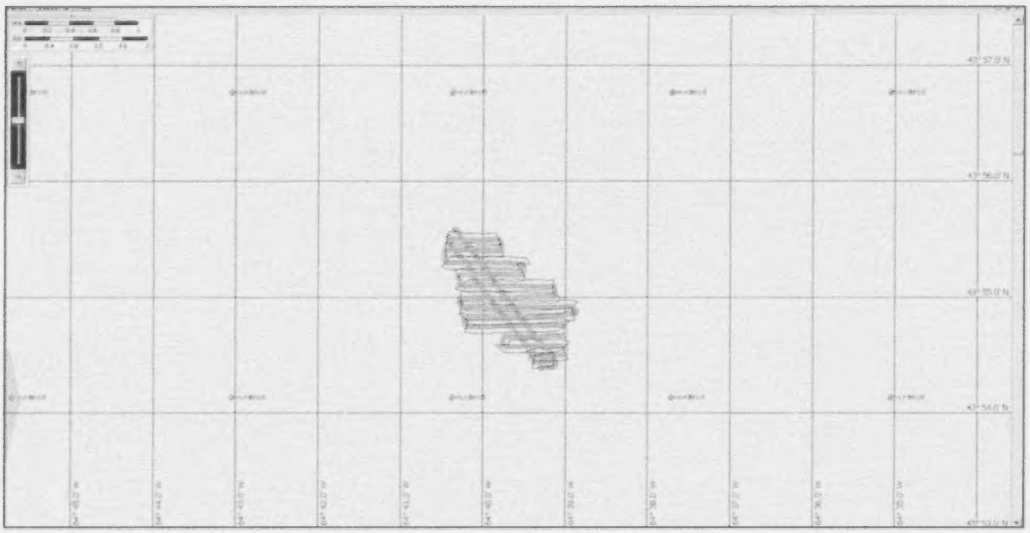

Figure 59B. Little Hope/Port Mouton herring gillnet survey (#2) on October 10, 2012, showing transects for the school area. A single school was surveyed using the Simrad ES70 (120 kHz) echosounder. Multi-panel herring gillnet sample collected on October 9 (see Figure 61B).

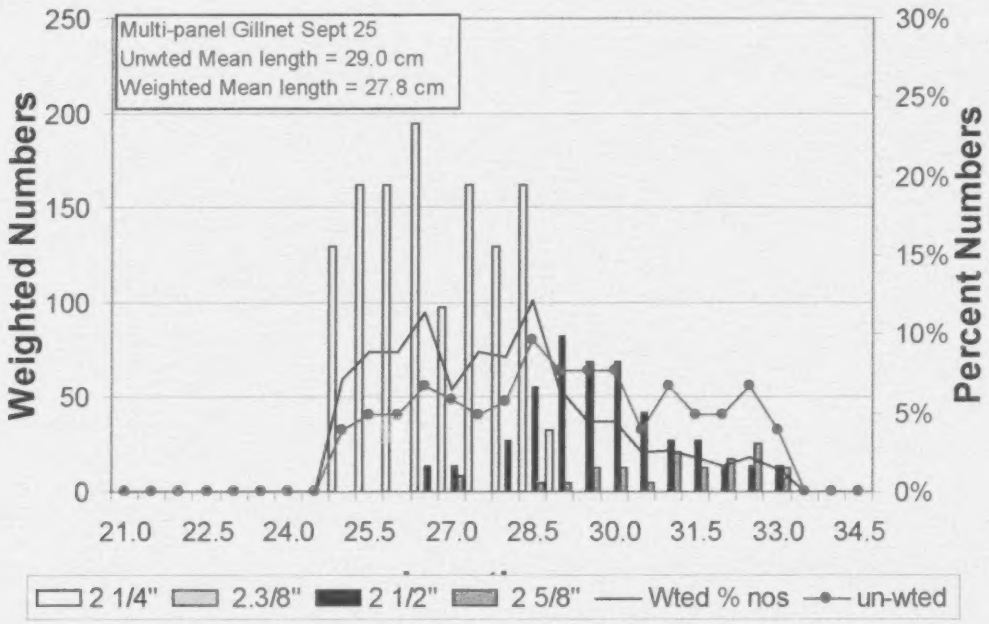

Figure 60. Multi-panel herring gillnet sample collected on September 25, 2012, for Little Hope/Port Mouton herring gillnet survey (#1) on September 24.

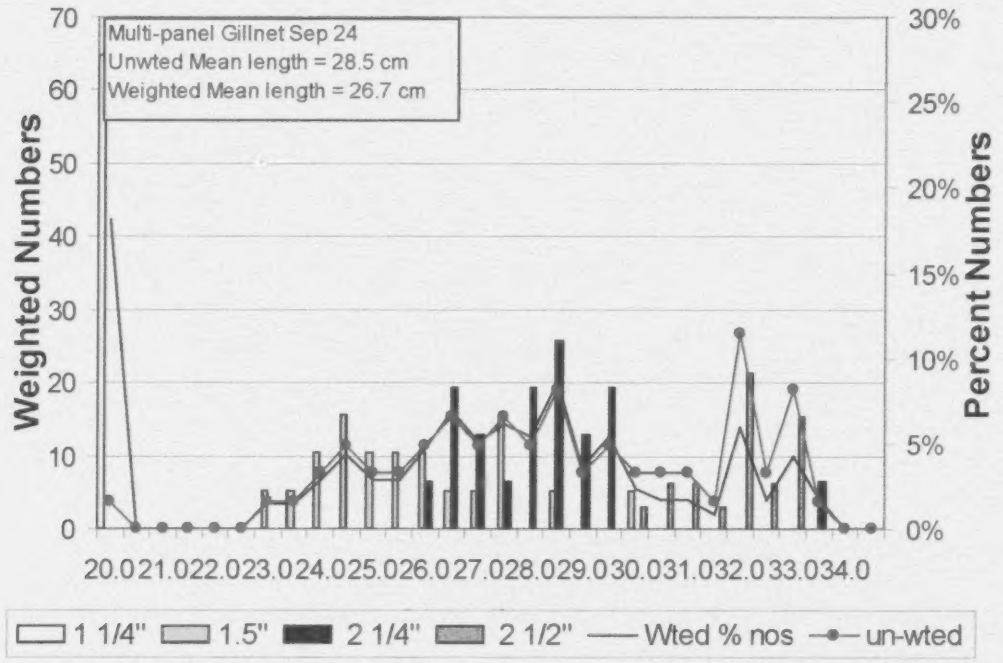

Figure 61A. Multi-panel herring gillnet sample collected on September 24, 2011, for Little Hope/Port Mouton herring gillnet survey (#2b) on September 27.

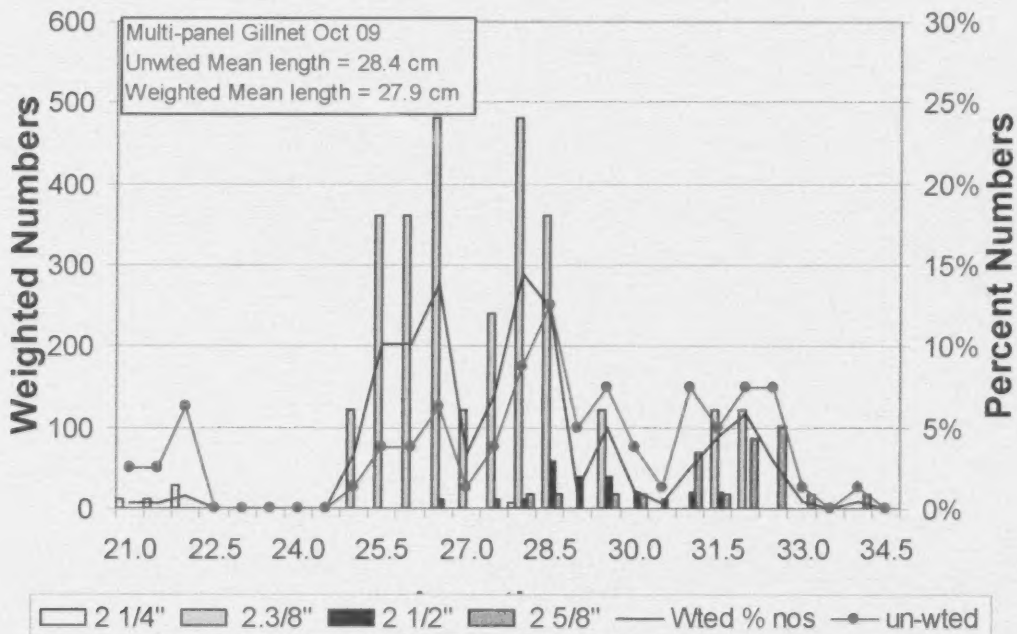

Figure 61B. Multi-panel herring gillnet sample collected on October 9, 2012, for Little Hope/Port Mouton herring gillnet survey (#2) on October 10.

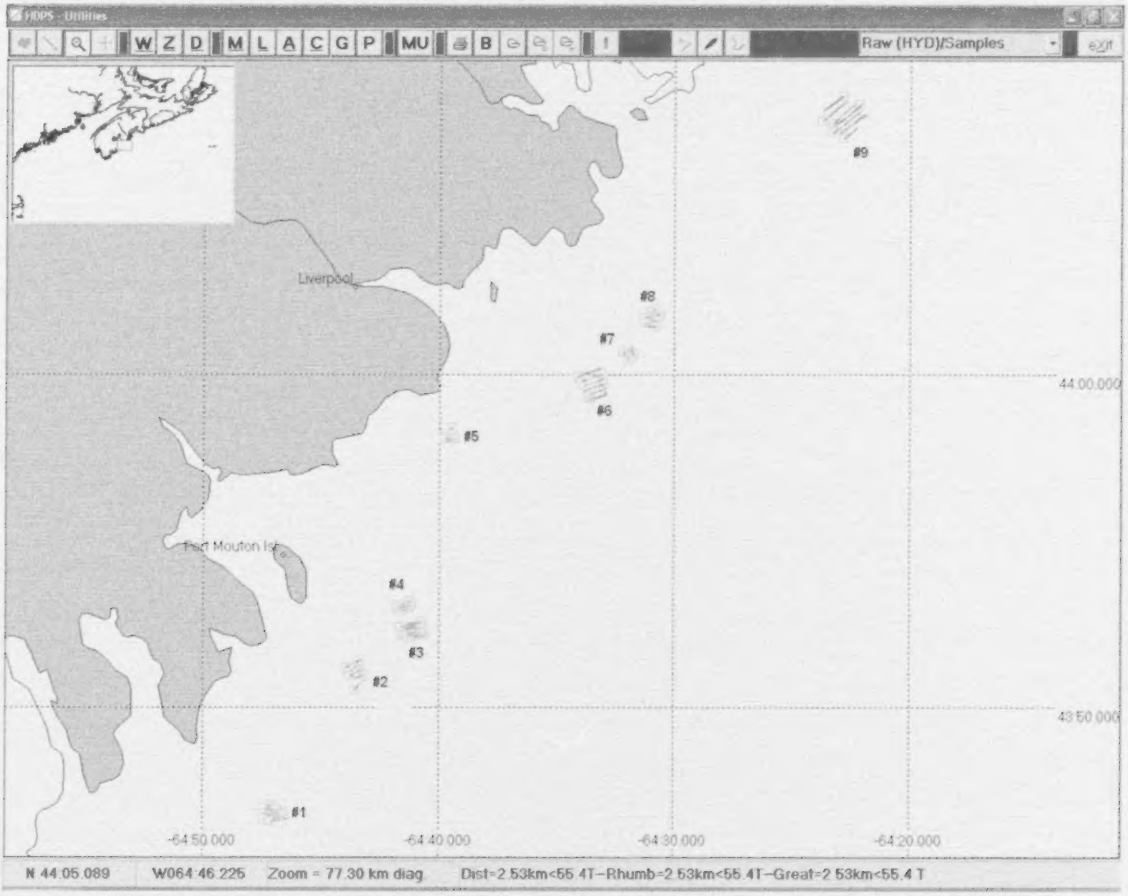

Figure 62. Little Hope/Port Mouton herring gillnet survey (#3) on October 7, 2011, showing transects for each of the school areas. No multi-panel samples, standard TS used.

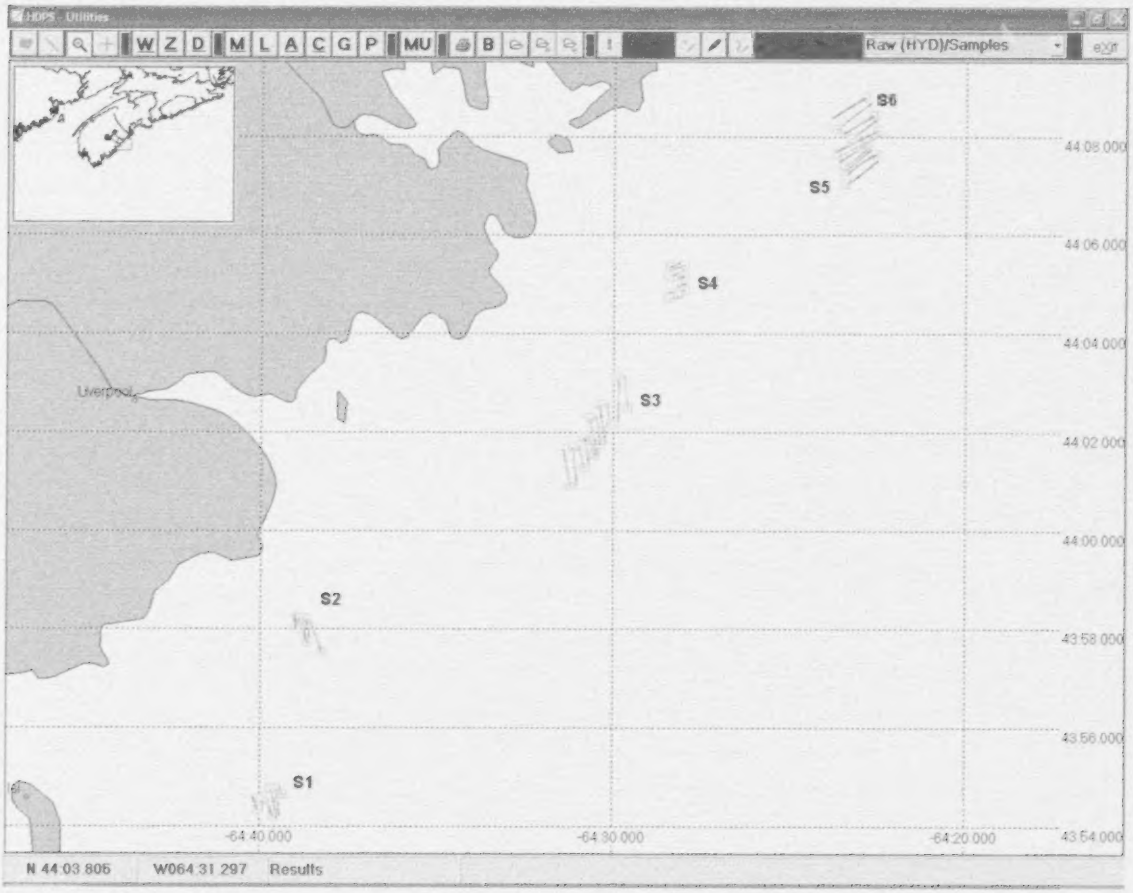

Figure 63. Little Hope/Port Mouton herring gillnet survey (#4) on October 18, 2011, showing transects for each of the school areas. No multi-panel samples, standard TS used.

Figure 64. Little Hope/Port Mouton herring gillnet survey (#6) on October 28, 2011, showing transects for each of the school areas. Multi-panel herring gillnet sample collected on October 28 (see Figure 65).

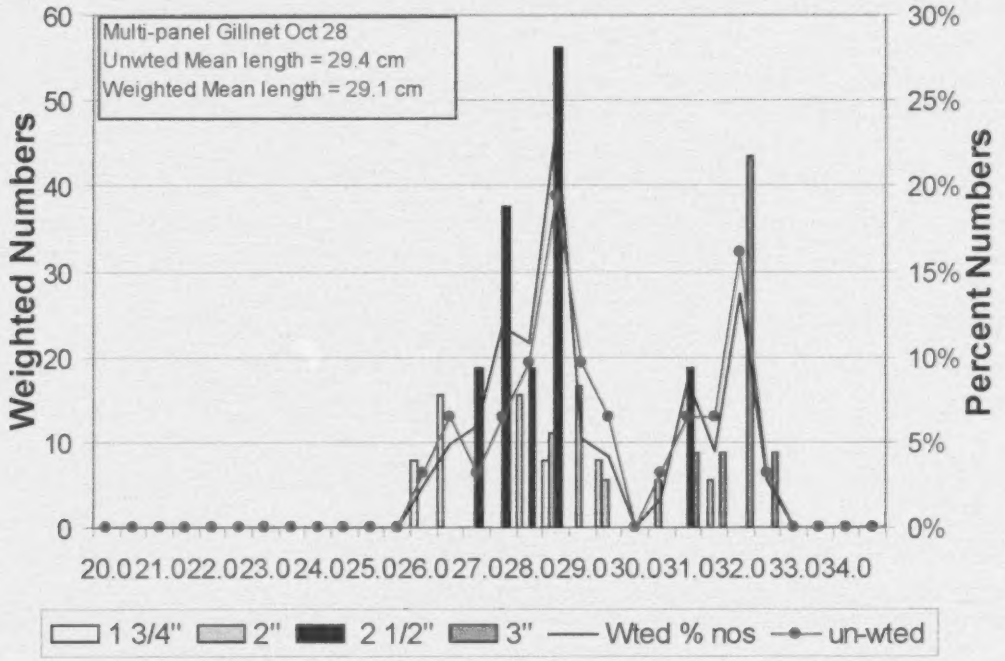

Figure 65. Multi-panel herring gillnet sample collected on October 28, 2011, for Little Hope/Port Mouton herring gillnet survey (#6) on October 28.

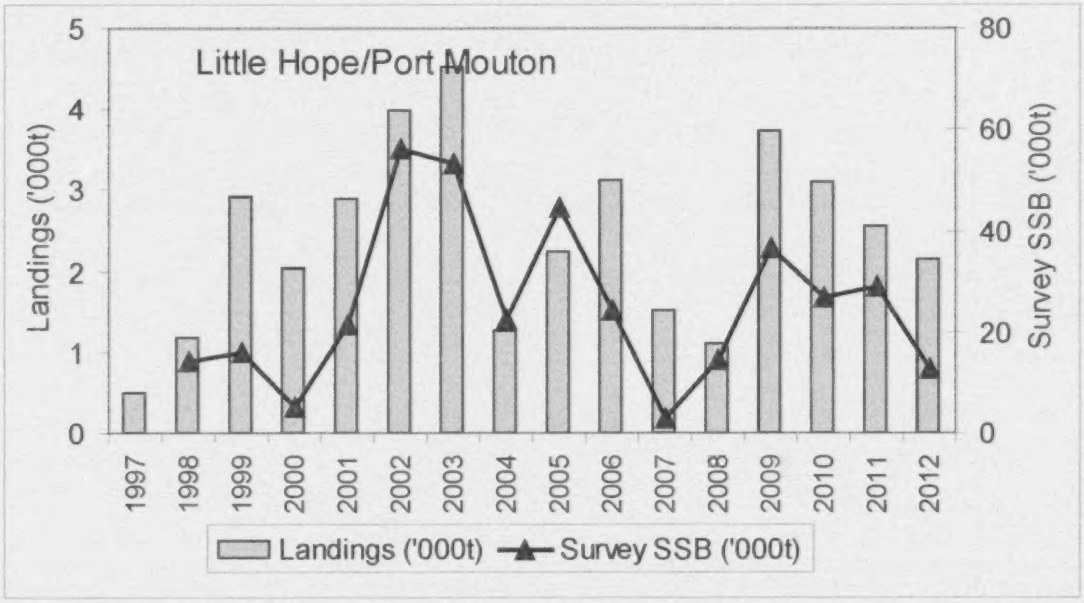

Figure 66. Little Hope/Port Mouton herring catches and acoustic survey biomass estimates from 1997-2012. (Acoustic survey SSB 1998-2002 'without' the CIF; 2003-2012 with the CIF).

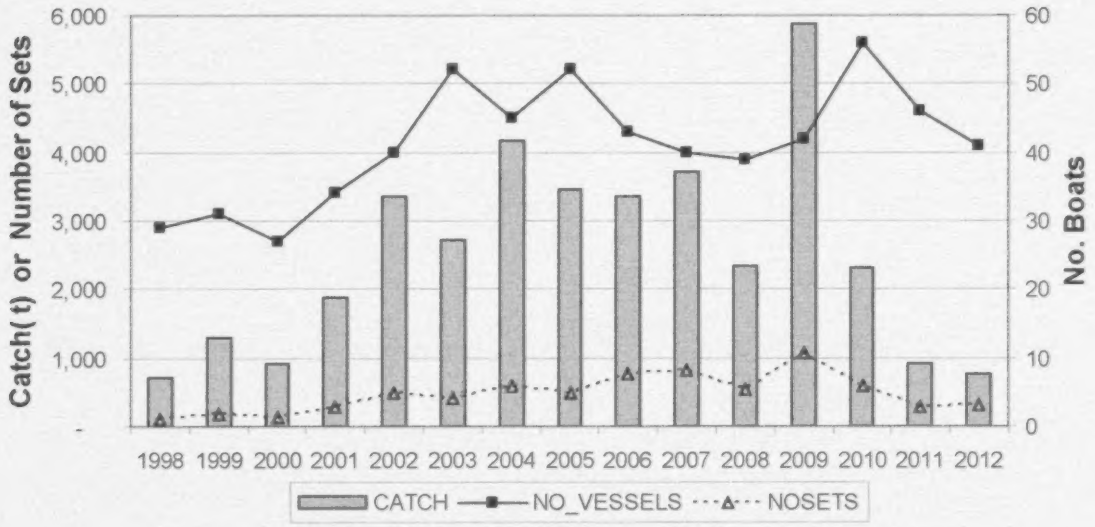

Figure 67. Herring gillnet total catch and total effort in number of vessels and number of sets for the Halifax/Eastern Shore area for 1998-2012. Data for statistical districts 18-21 inclusive.

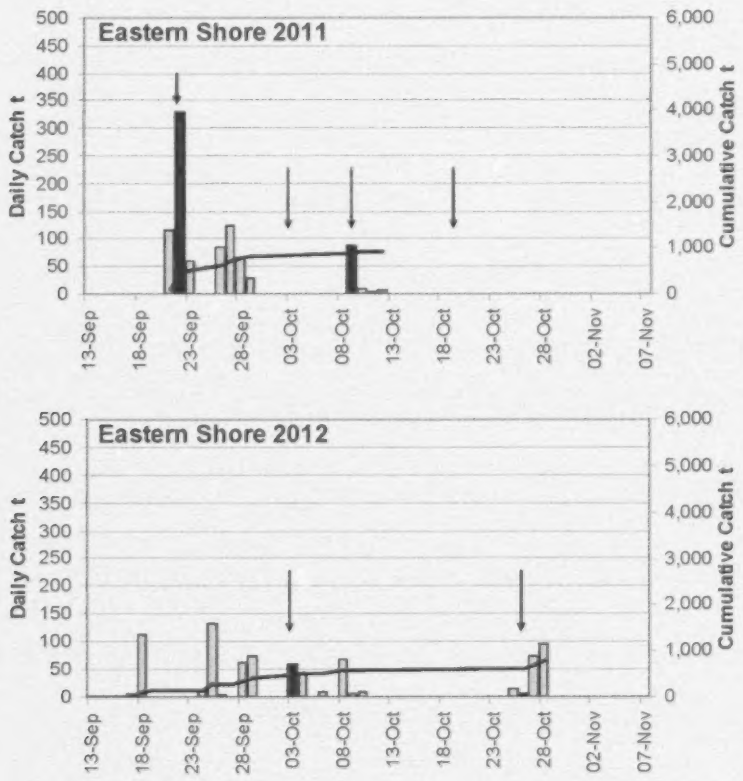

Figure 68. Daily and cumulative catch for the 2011 and 2012 Halifax/Eastern Shore herring gillnet fishery. Survey dates are identified by black columns or arrows indicating time of survey.

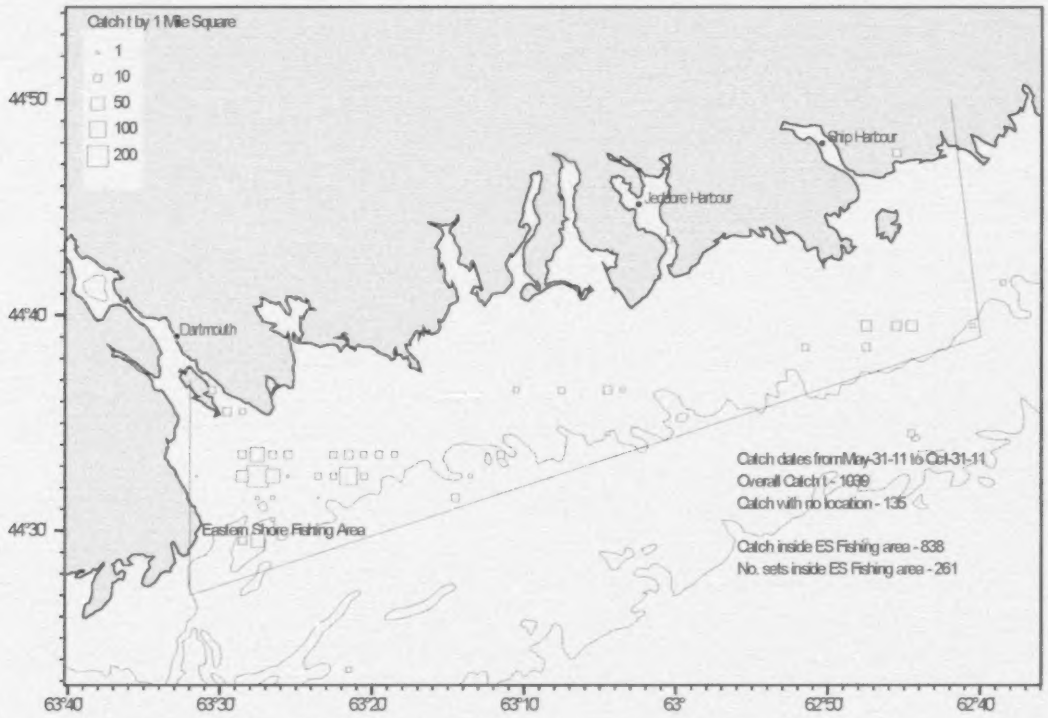

Figure 69A. Herring fishery gillnet catches for the Halifax/Eastern Shore area for 2011.

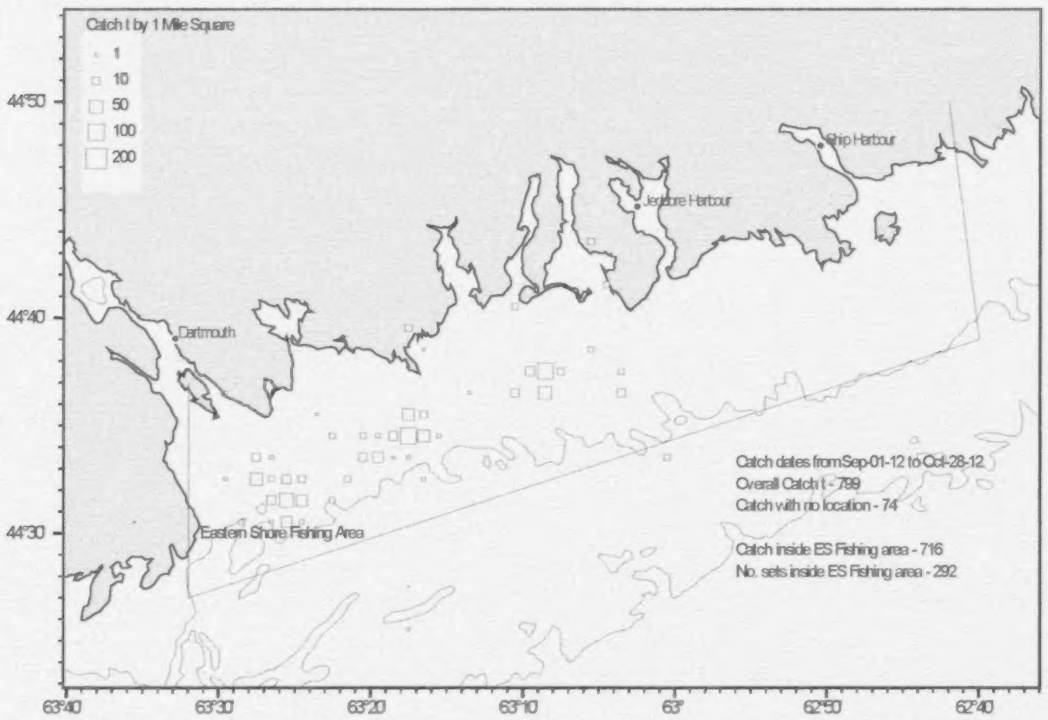

Figure 69B. Herring fishery gillnet catches for the Halifax/Eastern Shore area for 2012.

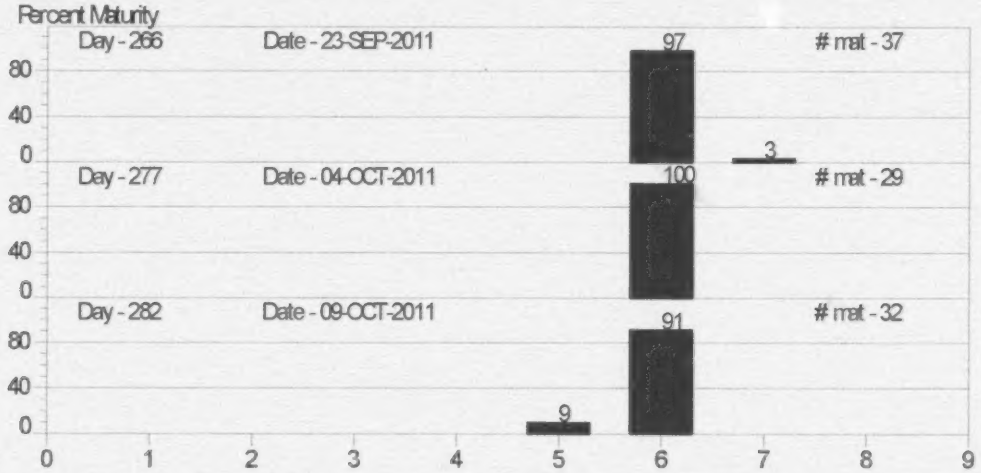

Figure 70A. Halifax/Eastern Shore herring maturity sample data from gillnet multi-panel nets in 2011. (Staging codes 1-2=immature; 3-4-5=maturing/hard; 6=ripe and running; 7=spent; 8=recovering).

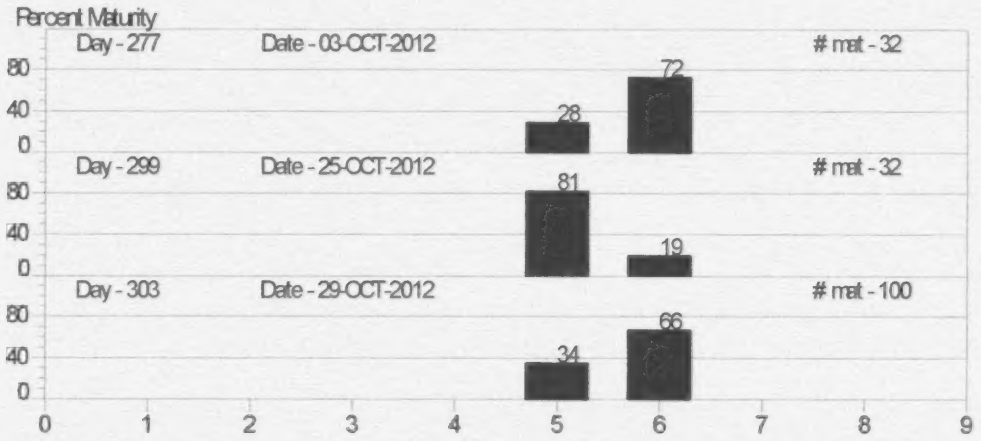

Figure 70B. Halifax/Eastern Shore herring maturity sample data from gillnet multi-panel nets in 2012. (Staging codes 1-2=immature; 3-4-5=maturing/hard; 6=ripe and running; 7=spent; 8=recovering).

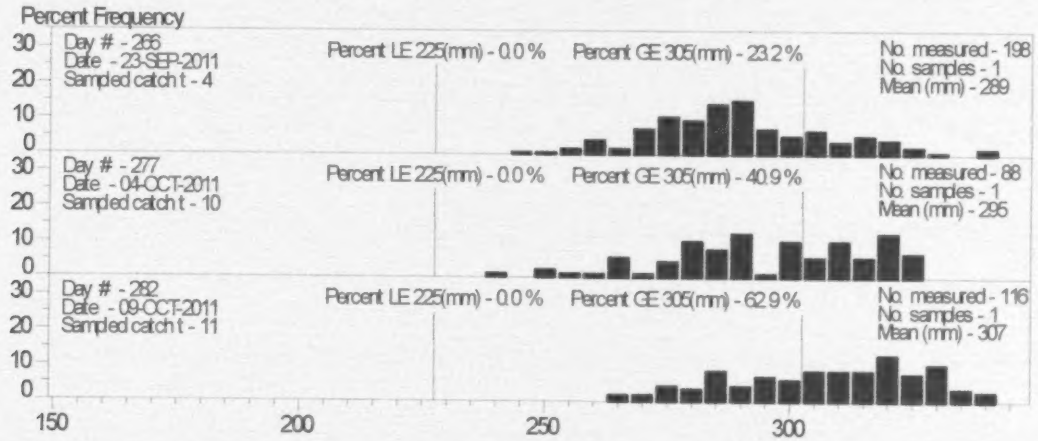

Figure 71A. Halifax/Eastern Shore daily length frequency sampling from multi-panel gillnet samples in 2011, with proportions <23cm and >30cm.

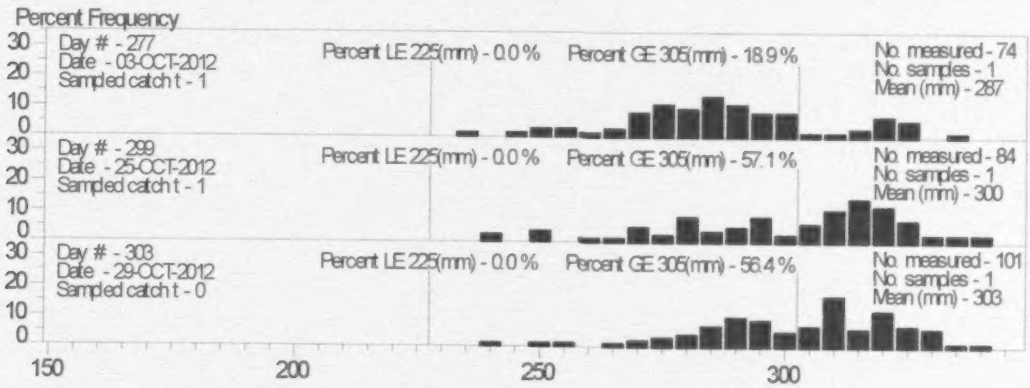

Figure 71B. Halifax/Eastern Shore daily length frequency sampling from multi-panel gillnet samples in 2012, with proportions <23cm and >30cm.

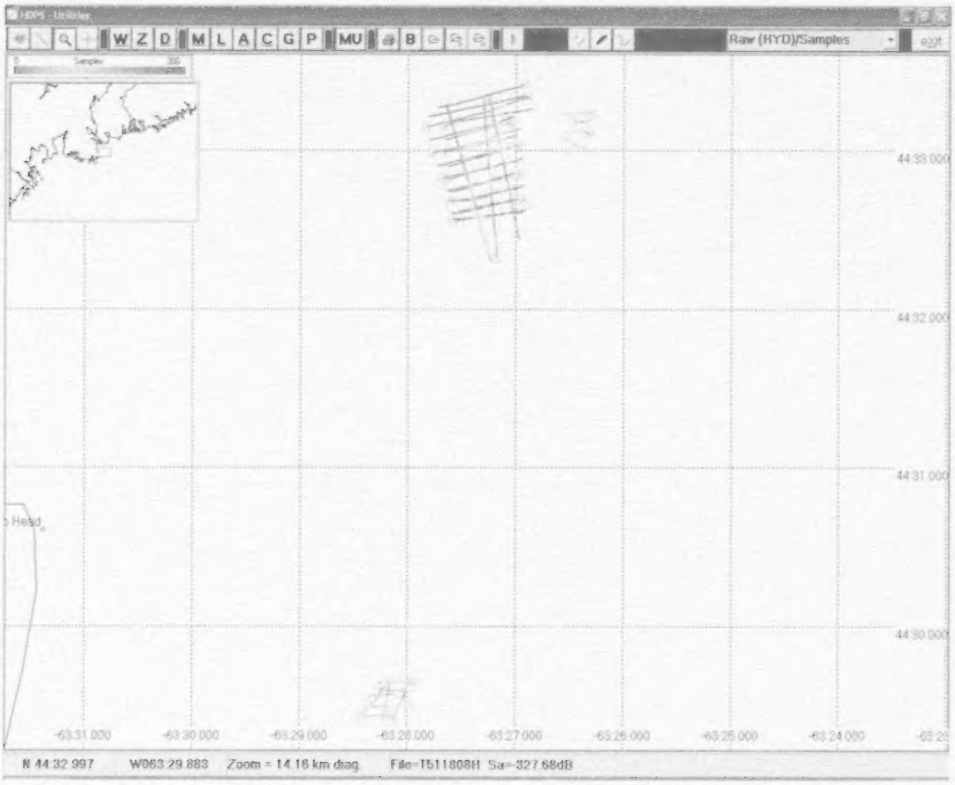

Figure 72. Halifax/Eastern Shore acoustic survey (#1) transects for September 22, 2011, survey conducted by three acoustic survey vessels, the Bradley K, Miss Owls Head, and TBS. Multi-panel herring gillnet sample collected on September 23 (see Figure 73).

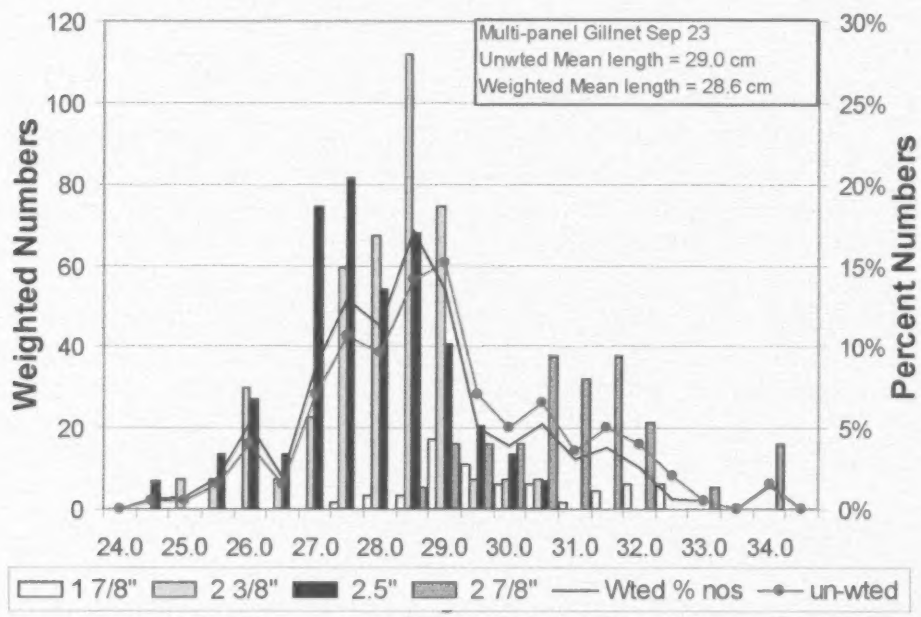

Figure 73. Multi-panel herring gillnet sample collected on September 23, 2011, for Halifax/Eastern Shore survey (#1) on September 22.

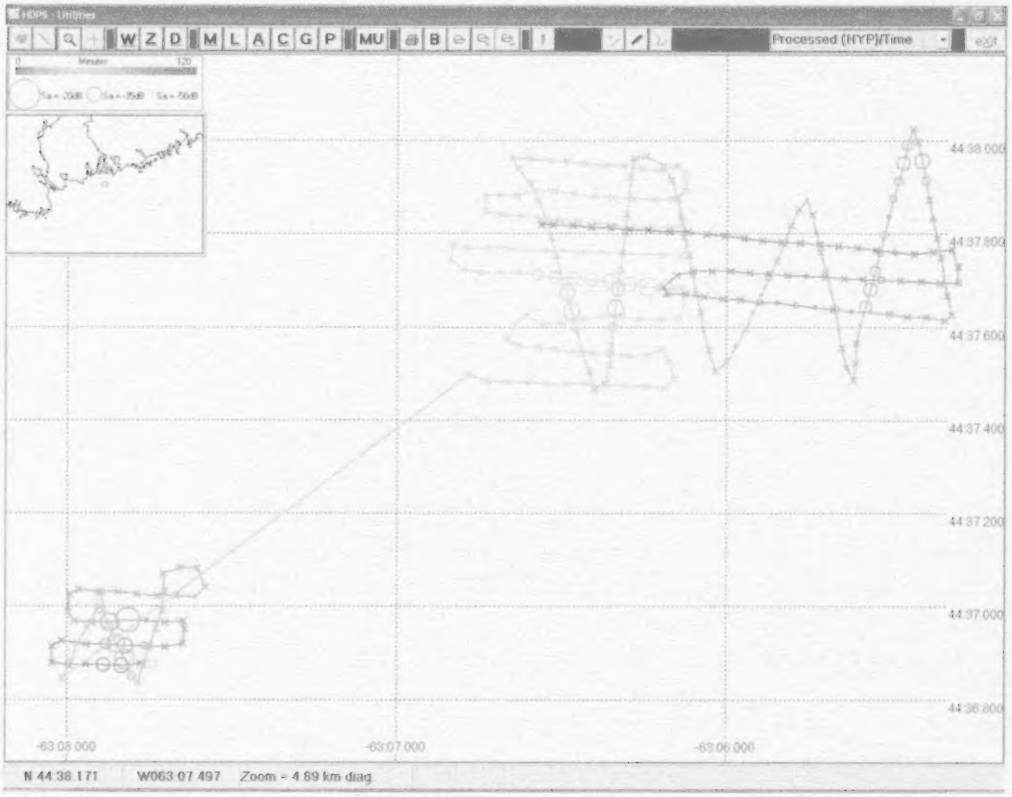

Figure 74A. Halifax/Eastern Shore herring gillnet survey (#2) lines for October 3, 2011, school surveys conducted by one acoustic survey vessel, the Bradley K. Multi-panel herring gillnet sample collected on October 4 (see Figure 75A).

Figure 74B. Halifax/Eastern Shore herring gillnet survey (#1) lines for October 3, 2012, school surveys conducted by two acoustic survey vessels, the Bradley K and Miss Owls Head. Multi-panel herring gillnet sample collected on October 10 (see Figure 75B).

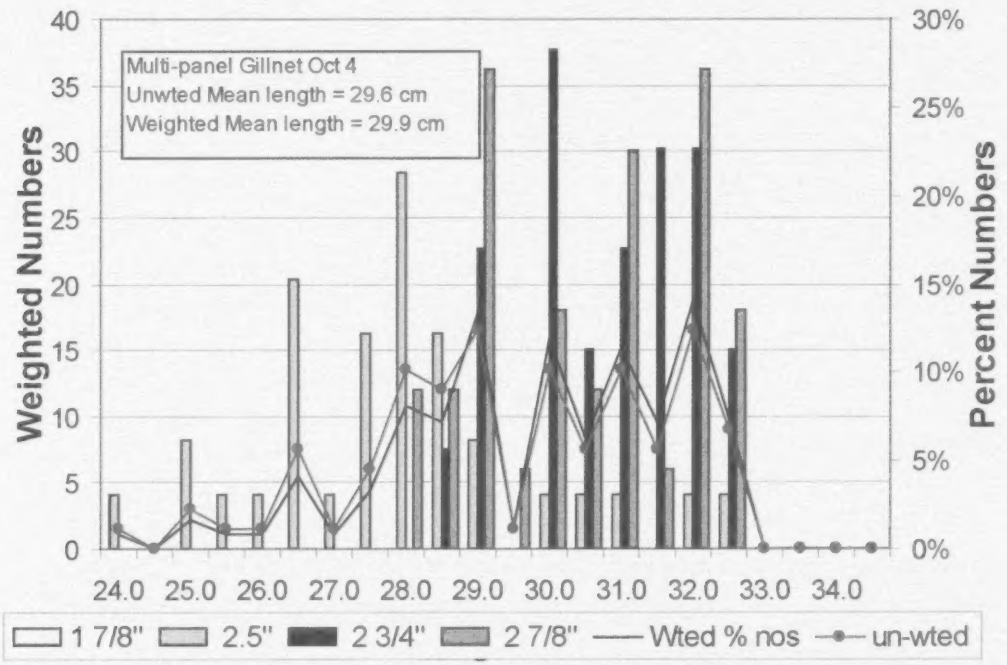

Figure 75A. Multi-panel herring gillnet sample collected by Bradley K on October 4, 2011, for Halifax/Eastern Shore survey (#2) on October 3.

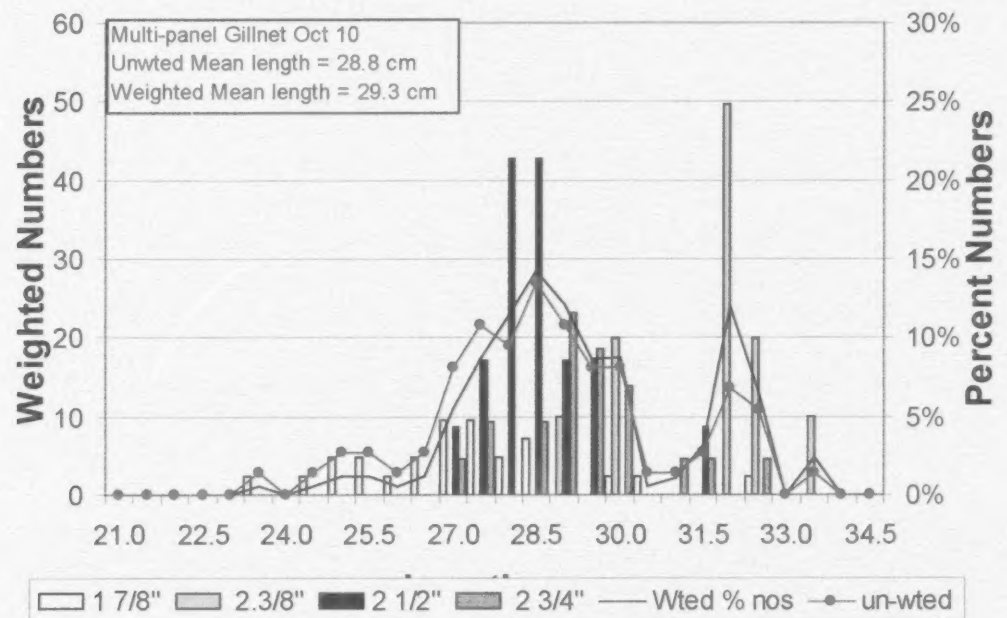

Figure 75B. Multi-panel herring gillnet sample collected by Bradley K on October 10, 2012, for Halifax/Eastern Shore survey (#1) on October 3.

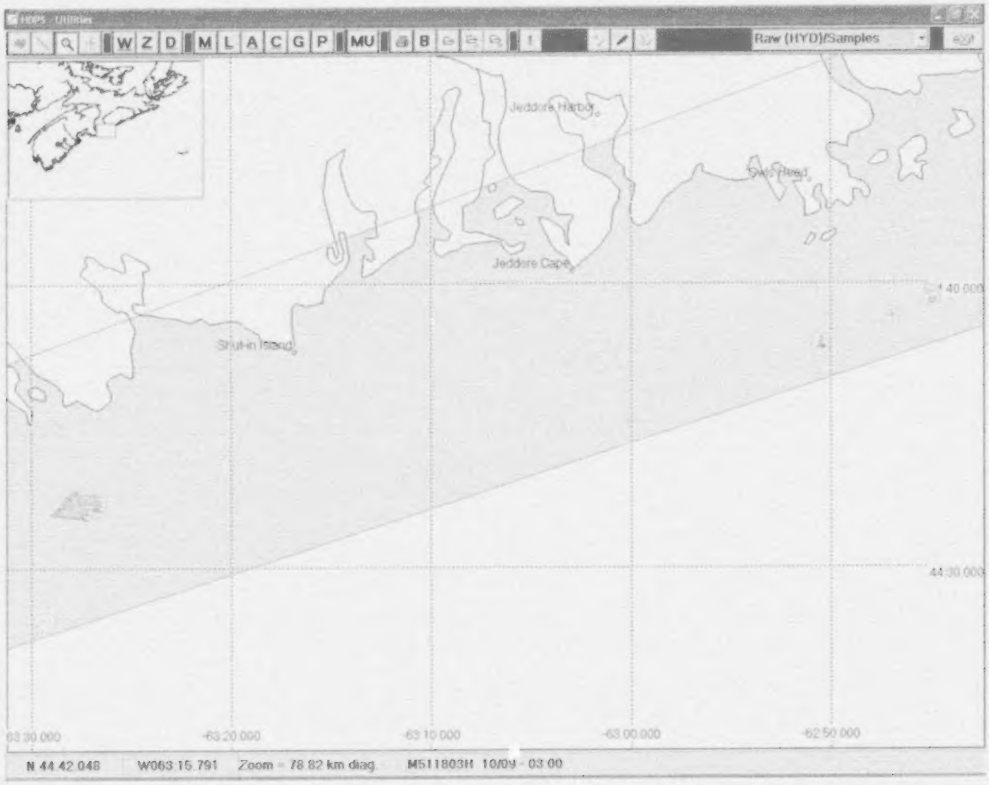

Figure 76A. Halifax/Eastern Shore acoustic transects for October 8, 2011, survey (#3) conducted by three acoustic survey vessels, the Bradley K, Miss Owls Head, and TBS. Multi-panel herring gillnet sample collected on October 9 (see Figure 77A).

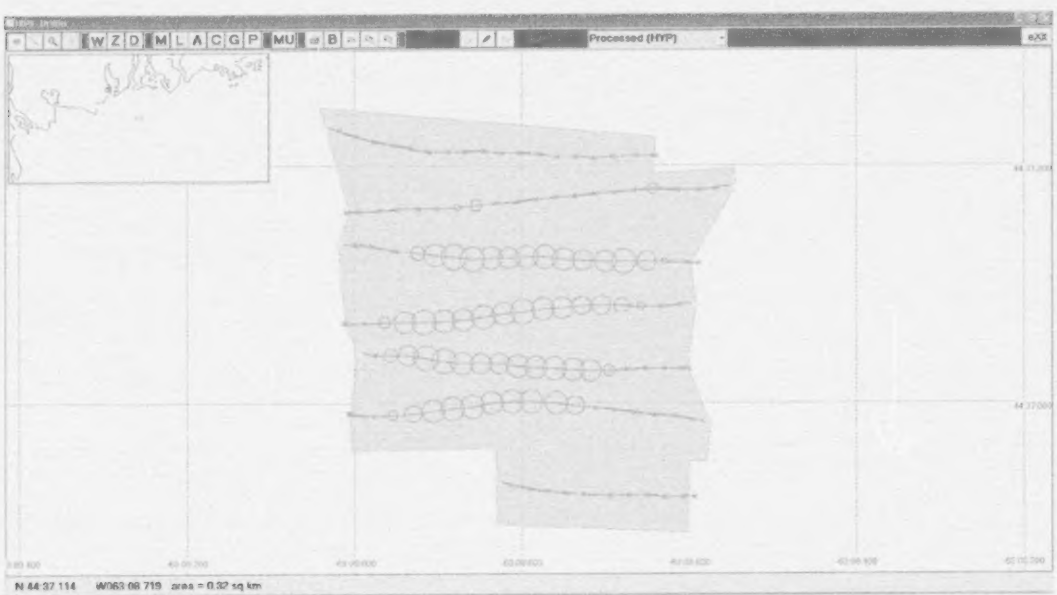

Figure 76B. Halifax/Eastern Shore acoustic transects for October 26, 2012, survey (#2) conducted by one acoustic survey vessel, the Bradley K. Multi-panel herring gillnet sample collected on October 25 (see Figure 77B).

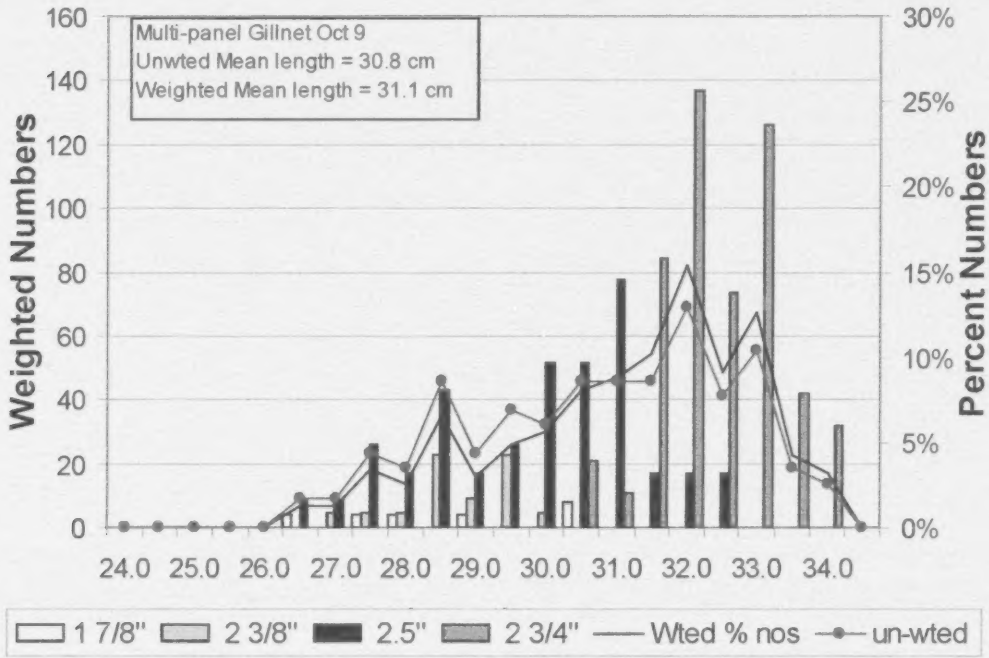

Figure 77A. Multi-panel herring gillnet sample collected by Bradley K on October 9, 2011, for Halifax/Eastern Shore survey (#3) on October 8.

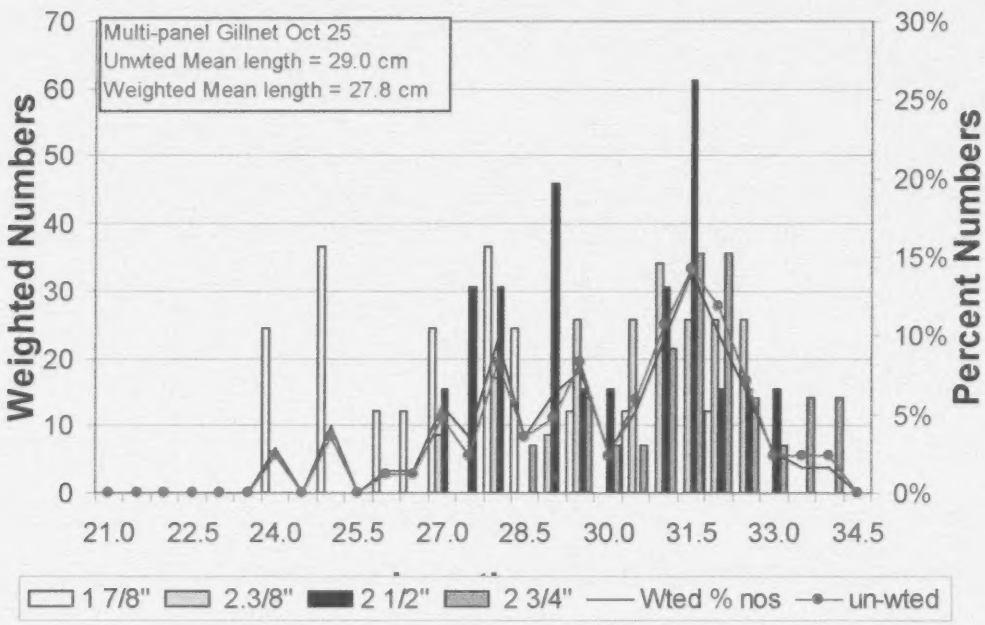

Figure 77B. Multi-panel herring gillnet sample collected by Bradley K on October 25, 2012, for Halifax/Eastern Shore survey (#2) on October 26.

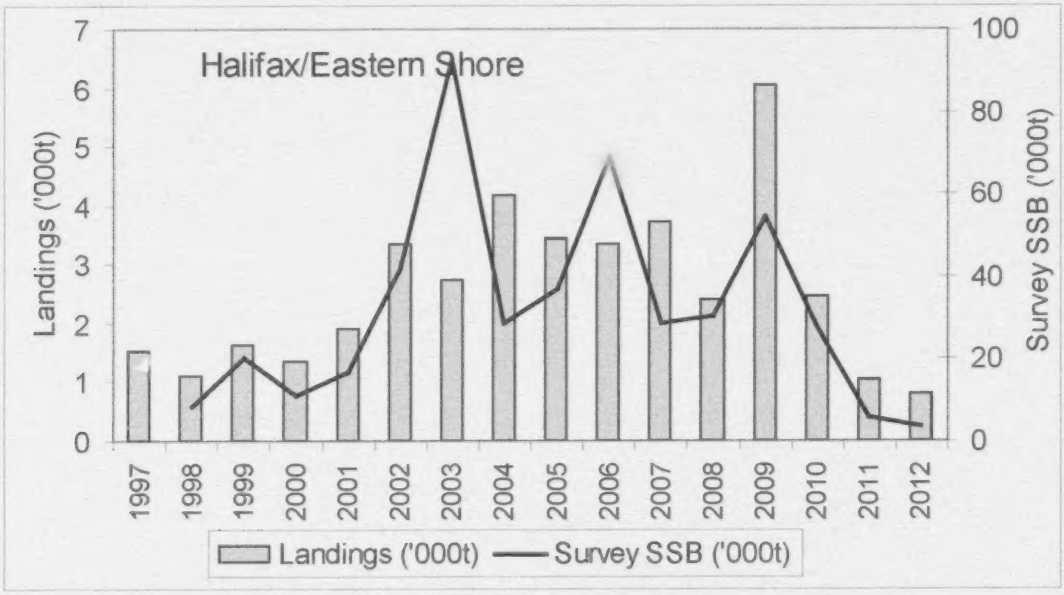

Figure 78. Halifax/Eastern Shore herring catches and acoustic survey biomass estimates from 1997-2012. (Acoustic survey SSB 1998-2002 'without' the CIF; 2003-2012 with the CIF).

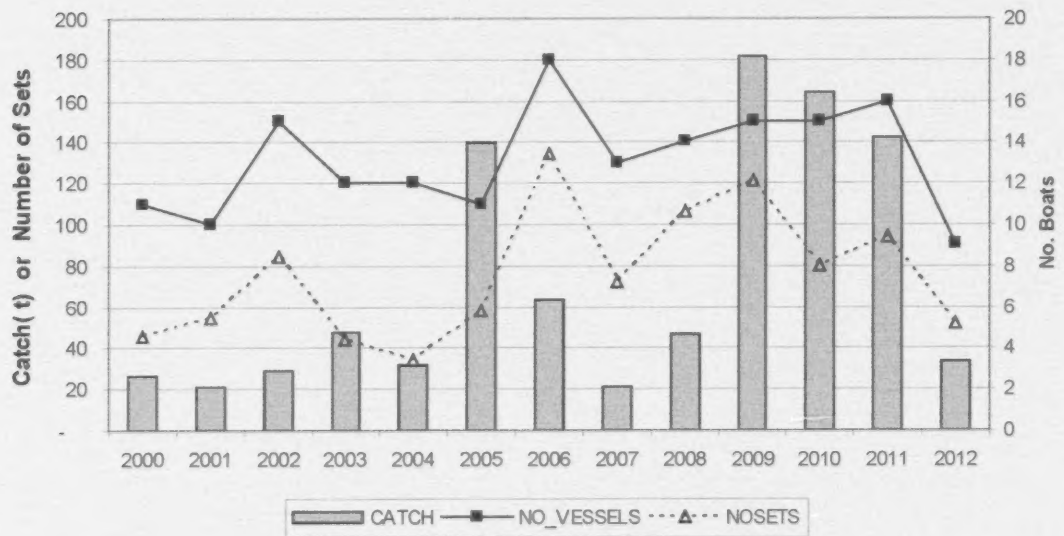

Figure 79. Herring gillnet total catch and total effort in number of vessels and number of sets for the Lunenburg Box area from Liverpool to Chebucto Head area (statistical districts 22-26) for 2000-2012. Note overlap of district 26 data with the Little Hope area used in Figure 53.

Figure 80. Glace Bay herring gillnet survey lines on September 15, 2011. No multi-panel samples, standard TS used.

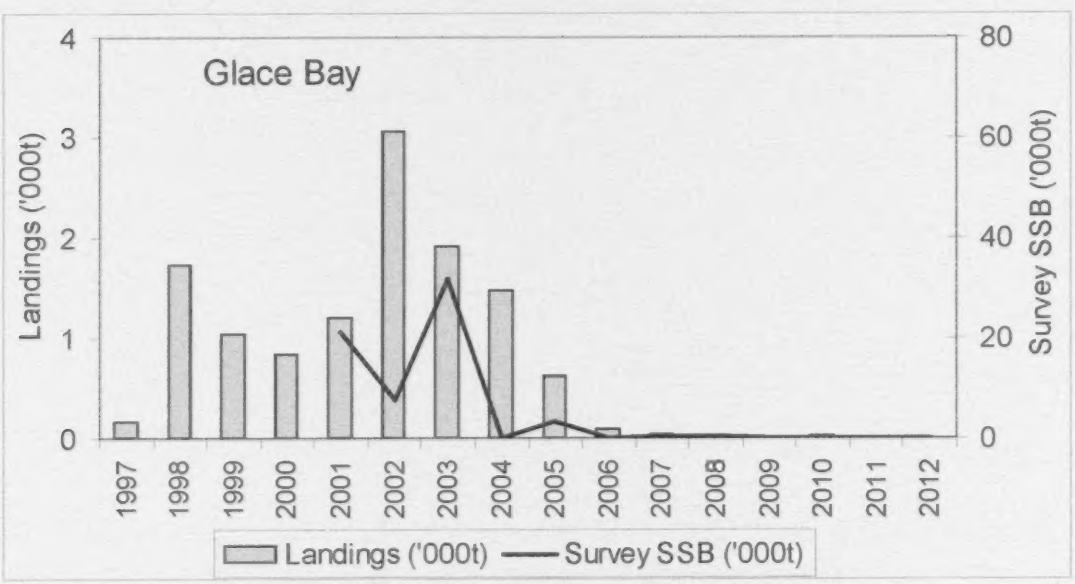

Figure 81. Glace Bay herring catches and acoustic survey biomass estimates from 1997-2012. No survey was completed in 2012. (Acoustic survey SSB 1998-2002 'without' the CIF; 2003-2010 with the CIF).

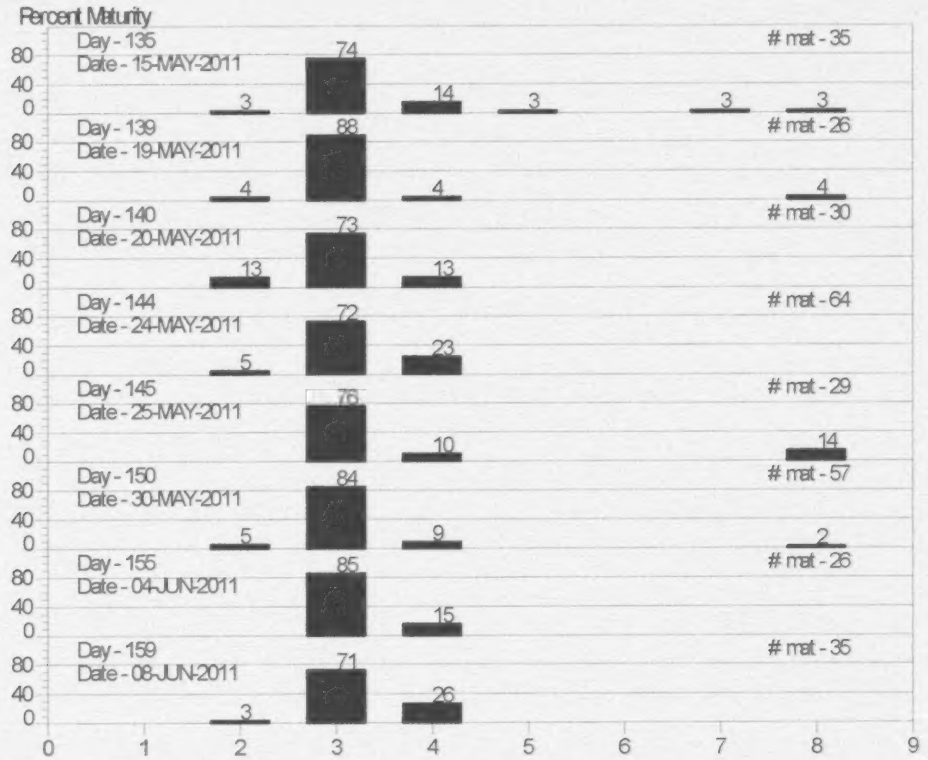

Figure 82A. Offshore Banks purse seine maturity samples in 2011.

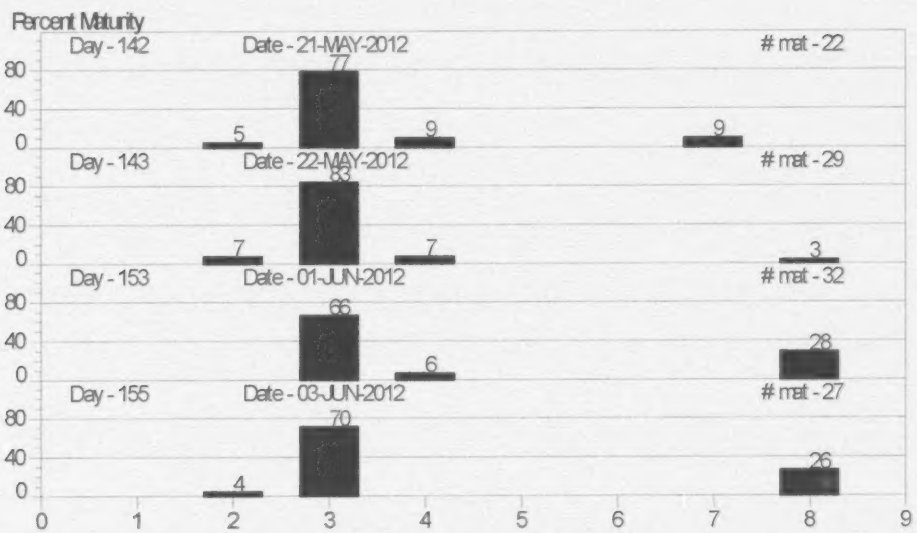

Figure 82B. Offshore Banks purse seine maturity samples in 2012.

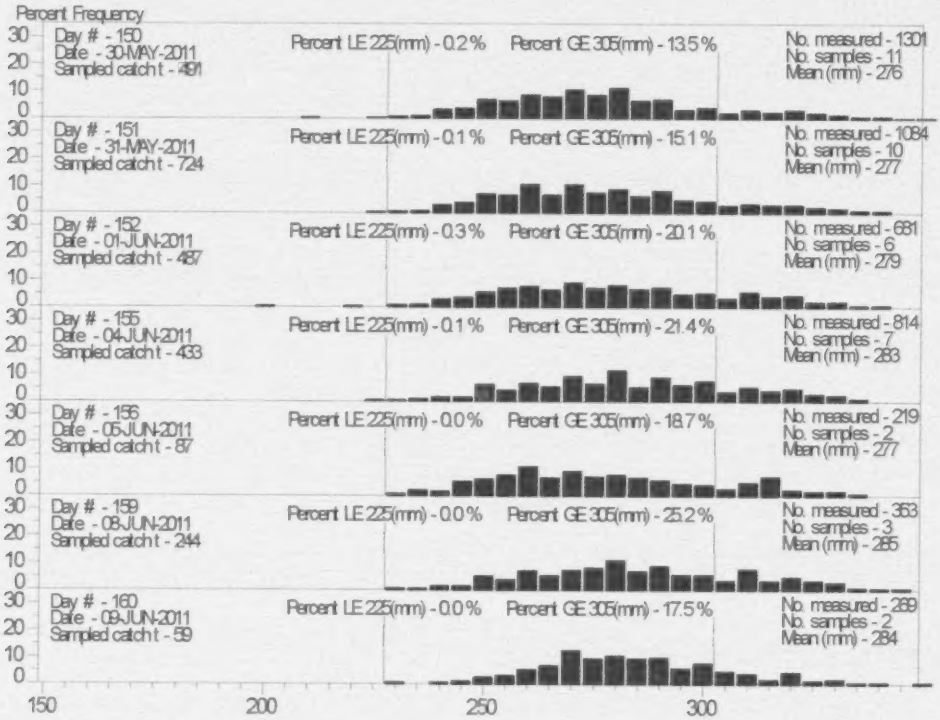

Figure 83A. Offshore Banks purse seine length samples in 2011.

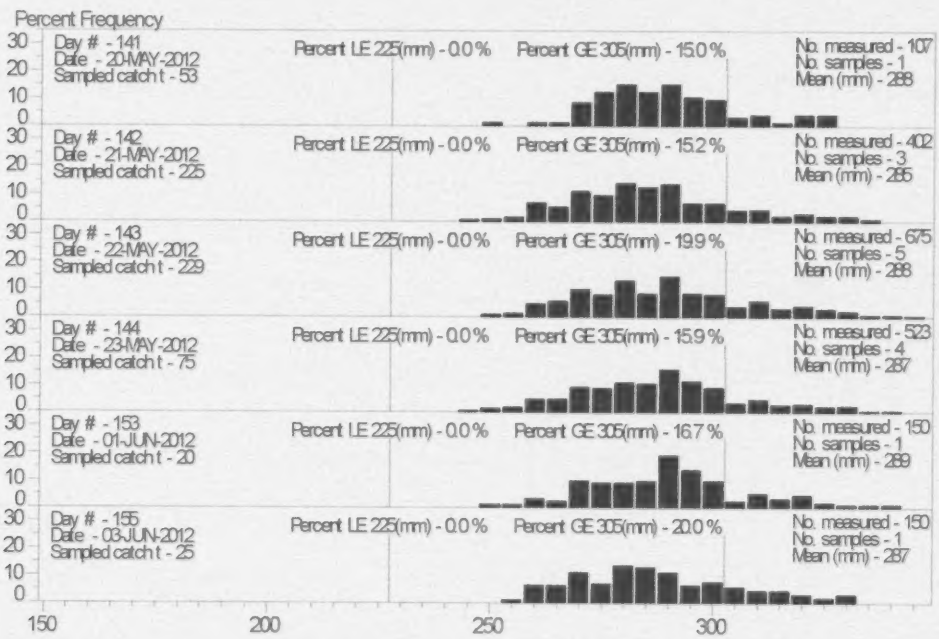

Figure 83B. Offshore Banks purse seine length samples in 2012.

APPENDIX

A. Acoustic Surveys Summary Details by Survey

Table A1. Scots Bay acoustic survey (#1) on July 2, 2011, using sample TS from fishery samples on July 4-5.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
In_box	-35.13	626	-50.146	0.0315	19712	7611	39
Eastern_edge_of_box	-35.13	21	-54.615	0.0113	236	143	60
East_of_box	-35.11	156	-44.687	0.1102	17185	9706	56
North_of_box	-35.16	120	-58.369	0.0048	573	251	44
Total	-35.13	923	-49.007	0.0409	37705	12,338	33
Out box only	-35.13	297	-47.286	0.0606	17994	9,710	54

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
In_box	A411805H	33.466	-35.16	-57.291	0.0061
	B411803H	35.771	-35.31	-48.908	0.0437
	B411805H	34.167	-35.31	-58.592	0.0047
	C211703H	44.365	-35.31	-56.457	0.0077
	C211705H	39.089	-35.31	-52.933	0.0173
	M411703H	41.888	-35.05	-46.644	0.0693
	M411705H	36.561	-35.05	-59.490	0.0036
	M421703H	41.903	-35.05	-43.735	0.1353
	M421705H	37.035	-35.05	-52.813	0.0167
	P411703H	45.441	-35.31	-59.669	0.0037
	P411705H	40.631	-35.31	-50.933	0.0274
Eastern_edge_of_box	A411804H	1.820	-35.16	-66.843	0.0007
	B411802H	1.212	-35.31	-64.602	0.0012
	B411804H	1.945	-35.31	-62.015	0.0021
	C211702H	1.447	-35.31	-1021.606	0.0000
	C211704H	1.512	-35.31	-1021.794	0.0000
	M411702H	1.510	-35.05	-46.604	0.0699
	M421702H	1.380	-35.05	-57.859	0.0052
	M421704H	1.670	-35.05	-59.433	0.0036
	P411702H	1.282	-35.31	-52.838	0.0177
	P411704H	1.458	-35.31	-53.313	0.0159
East_of_box	C211600H	12.404	-35.31	-45.969	0.0860
	C211601H	16.100	-35.31	-55.682	0.0092
	M411600H	4.932	-35.05	-47.498	0.0569
	M411601H	17.851	-35.05	-54.508	0.0113
	M421600H	12.211	-35.05	-37.737	0.5385
	M421601H	17.056	-35.05	-44.232	0.1207
	P411600H	10.604	-35.31	-53.837	0.0141
	P411601H	15.768	-35.31	-46.157	0.0824
North_of_box	A411801H	24.412	-35.16	-55.711	0.0088
	A411802H	22.908	-35.16	-60.647	0.0028
	A411803H	21.565	-35.16	-61.572	0.0023

Table A2. Scots Bay acoustic survey (#2) on July 16, 2011, using sample TS from fishery samples on July 17-18.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
North_of_box	-35.03	132	-48.984	0.0403	5317	1908	36
East_of_box	-35.13	160	-55.926	0.0083	1334	709	53
Eastern_edge_of_box	-35.19	20	-47.921	0.0533	1067	1723	162
Box_only	-35.12	626	-48.184	0.0493	30883	12310	40
Total	-35.12	938	-48.963	0.0412	38600	12,596	33
Out_box_only	-35.12	312	-51.140	0.0247	7717	12,450	161

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
North_of_box	A411800H	22.196	-35.03	-49.608	0.0349
	A411801H	23.247	-35.03	-46.407	0.0729
	A411802H	24.955	-35.03	-47.858	0.0522
	A411803H	26.244	-35.03	-58.414	0.0046
East_of_box	C211700H	11.410	-35.19	-54.679	0.0113
	C211701H	15.986	-35.19	-90.170	0.0000
	K411700H	10.952	-35.19	-67.471	0.0006
	K411701H	15.210	-35.19	-66.282	0.0008
	M411700H	13.770	-34.93	-59.426	0.0036
	M411701H	17.934	-34.93	-55.506	0.0088
	R411701H	15.829	-35.19	-49.504	0.0371
	R411700H	12.689	-35.19	-66.762	0.0007
Eastern_edge_of_box	B411803H	0.845	-35.19	-35.827	0.8643
	B411805H	1.686	-35.19	-60.606	0.0029
	C211603H	1.220	-35.19	-52.583	0.0182
	C211605H	1.404	-35.19	-1021.475	0.0000
	K411602H	1.211	-35.19	-65.421	0.0009
	K411604H	1.503	-35.19	-71.552	0.0002
	M411602H	1.430	-34.93	-60.243	0.0029
	M411604H	2.004	-34.93	-65.415	0.0009
	R411602H	1.346	-35.19	-69.576	0.0004
	R411604H	1.699	-35.19	-76.665	0.0001
Box_only	B411802H	35.680	-35.19	-51.496	0.0234
	B411804H	29.791	-35.19	-45.916	0.0847
	C211602H	44.502	-35.19	-53.359	0.0153
	C211604H	39.261	-35.19	-60.670	0.0028
	K411603H	45.624	-35.19	-55.198	0.0100
	K411605H	40.498	-35.19	-57.011	0.0066
	M411603H	41.613	-34.93	-44.704	0.1053
	M411605H	36.432	-34.93	-49.688	0.0334
	R411603H	43.009	-35.19	-42.266	0.1962
	R411605H	38.087	-35.19	-53.591	0.0145

Table A3. Scots Bay acoustic survey (#3) on July 30, 2011, using sample TS from fishery samples on July 25-26.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
In_box_only	-35.11	626	-47.893	0.0526	32956	18114	55
North_of_box	-35.25	95	-59.266	0.0040	377	28	7
Eastern_edge_of_box	-35.25	23	-60.879	0.0027	63	30	47
East_of_spawning_box	-35.24	166	-56.719	0.0071	1180	768	65
Total	-35.21	910	-49.316	0.0380	34576	18,130	52
Outbox_only	-35.25	284	-57.679	0.0057	1620	769	47

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
In_box	A411703H	34.203	-35.18	-57.832	0.0054
	A411705H	41.477	-35.18	-54.032	0.0130
	B411703H	33.236	-35.34	-63.105	0.0017
	C211703H	44.202	-35.34	-51.355	0.0250
	C211705H	37.774	-35.34	-57.915	0.0055
	L411703H	45.253	-35.08	-39.530	0.3585
	L411705H	39.242	-35.08	-55.603	0.0089
	M411703H	42.886	-35.08	-47.851	0.0528
	M411705H	37.245	-35.08	-51.507	0.0227
	S411703H	46.834	-35.18	-46.892	0.0675
	S411705H	40.334	-35.18	-60.685	0.0028
	S511703H	35.482	-35.18	-59.881	0.0034
North_of_box	B411701H	32.957	-35.34	-59.687	0.0037
	S511701H	33.526	-35.18	-58.888	0.0043
Eastern_edge_of_box	A411702H	1.645	-35.18	-65.433	0.0009
	A411704H	1.501	-35.18	-65.783	0.0009
	B411702H	1.725	-35.34	-70.384	0.0003
	C211702H	1.335	-35.34	-69.155	0.0004
	C211704H	1.651	-35.34	-53.260	0.0161
	L411702H	1.356	-35.08	-60.544	0.0028
	L411704H	1.603	-35.08	-60.461	0.0029
	M411702H	1.299	-35.08	-65.775	0.0009
	M411704H	1.798	-35.08	-67.873	0.0005
	S411702H	1.338	-35.18	-58.643	0.0045
	S411704H	1.492	-35.18	-68.542	0.0005
	S511702H	1.173	-35.18	-65.371	0.0010
East_of_spawning_box	A411601H	13.708	-35.18	-60.276	0.0031
	C211600H	11.266	-35.34	-48.882	0.0442
	C211601H	16.911	-35.34	-71.178	0.0003
	L411600H	10.494	-35.08	-58.223	0.0048
	L411601H	15.781	-35.08	-59.411	0.0037
	M411600H	12.374	-35.08	-59.822	0.0034
	M411601H	18.062	-35.08	-55.875	0.0083
	S411601H_NAV	14.780	-35.18	-66.630	0.0007
	S411600H_NAV	9.253	-35.18	-63.162	0.0016

Table A4. Scots Bay acoustic survey (#4) on August 13, 2011, using sample TS from fishery samples on August 15.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
In_box_only	-35.09	626	-51.319	0.0238	14928.1	4825	32
Eastern_edge_of_box	-35.03	20	-55.698	0.0086	171	98	57
East_of_survey_box	-35.06	155	-59.809	0.0033	519	98	19
North_of_survey_box	-35.07	120	-54.790	0.0107	1,280	760	59
Total	-35.06	921	-52.454	0.0183	16898.3	4,886	29
Out box only	-35.05	295	-56.816	0.0067	1970	773	39

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
In_box_only	B411703H	35.343	-35.23	-55.979	0.0084
	B411705H	34.047	-35.23	-65.712	0.0009
	C211703H	44.056	-35.23	-46.957	0.0671
	C211705H	39.173	-35.23	-62.988	0.0017
	M411703H	41.724	-34.96	-47.345	0.0578
	M411705H	36.892	-34.96	-57.337	0.0058
	N411703H	45.526	-35.07	-49.280	0.0379
	N411705H	40.382	-35.07	-60.849	0.0026
	T411703H	43.028	-35.07	-50.728	0.0272
	T411705H	37.804	-35.07	-53.737	0.0136
Eastern_edge_of_box	B411702H	1.022	-35.23	-1020.094	0.0000
	B411704H	1.831	-35.23	-1022.626	0.0000
	C211702H	1.528	-35.23	-70.354	0.0003
	C211704H	1.432	-35.23	-64.204	0.0013
	M411702H	1.440	-34.96	-63.340	0.0015
	M411704H	2.202	-34.96	-51.321	0.0231
	N411702H	1.185	-35.07	-58.966	0.0041
	N411704H	1.532	-35.07	-1021.851	0.0000
	T411702H	1.353	-35.07	-64.907	0.0010
	T411704H	1.416	-35.07	-48.353	0.0469
East_of_survey_box	C211600H	11.517	-35.23	-60.662	0.0029
	C211601H	16.133	-35.23	-62.775	0.0018
	M411600H	13.738	-34.96	-58.221	0.0047
	M411601H	18.076	-34.96	-59.665	0.0034
	N411600H	12.164	-35.07	-64.847	0.0011
	N411601H	14.946	-35.07	-57.663	0.0055
	T411601H	18.183	-35.07	-62.039	0.0020
	T411600H	12.962	-35.07	-57.428	0.0058
North_of_survey_box	A411500H	22.919	-35.07	-58.503	0.0045
	A411501H	23.014	-35.07	-59.101	0.0040
	A411502H	24.372	-35.07	-61.010	0.0025
	A411503H	26.953	-35.07	-50.453	0.0289

Table A5. Scots Bay acoustic survey (#5) on August 26, 2011, using sample TS from fishery samples on August 27-28.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
In_box	-35.07	626	-54.502	0.0114	7135	3522	49
Eastern_edge_of_box	-35.09	20	-52.870	0.0167	333	131	39
North_of_spawning_box	-34.98	125	-59.221	0.0038	471	103	22
East_of_spawning_box	-35.08	154	-49.969	0.0324	4,994	5340	107
Total	-35.06	925	-53.615	0.0140	12933	6399	49
Out_box_only	-35.05	299	-52.194	0.0194	5798	5343	92

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
In_box	B411703H	35.214	-35.14	-58.395	0.0047
	B411705H	34.445	-35.14	-59.601	0.0036
	C211703H	44.140	-35.14	-57.115	0.0063
	C211705H	39.081	-35.14	-59.066	0.0041
	M411703H	41.708	-34.88	-55.673	0.0083
	M411705H	37.834	-34.88	-1035.779	0.0000
	M421703H	42.856	-34.88	-54.133	0.0119
	M421705H	37.897	-34.88	-55.814	0.0081
	R411703H	45.100	-35.14	-58.453	0.0047
	R411705H	39.953	-35.14	-47.282	0.0611
Eastern_edge_of_box	B411700H	36.179	-35.14	-58.504	0.0046
	B411701H	36.072	-35.14	-59.774	0.0034
	C211700H	45.414	-35.14	-57.211	0.0062
	C211701H	40.556	-35.14	-59.014	0.0041
	M411700H	43.019	-34.88	-55.808	0.0081
	M411701H	39.806	-34.88	-1035.999	0.0000
	M421700H	44.249	-34.88	-54.136	0.0119
	M421701H	39.563	-34.88	-53.819	0.0128
	R411700H	46.399	-35.14	-48.136	0.0502
	R411701H	41.487	-35.14	-47.461	0.0586
North_of_spawning_box	A411500H	21.958	-34.98	-57.184	0.0060
	A411501H	23.094	-34.98	-60.997	0.0025
	A411502H	24.378	-34.98	-58.766	0.0042
	A411503H	26.165	-34.98	-60.828	0.0026
East_of_spawning_box	C211600H	11.443	-35.14	-64.269	0.0012
	C211601H	17.097	-35.14	-64.130	0.0013
	M411600H	13.633	-34.88	-50.558	0.0270
	M411601H	17.932	-34.88	-1032.536	0.0000
	M421600H	12.446	-34.88	-49.816	0.0321
	M421601H	15.880	-34.88	-58.416	0.0044
	R411600H	9.783	-35.14	-40.601	0.2844
	R411601H	14.523	-35.14	-1031.621	0.0000

Table A6. German Bank acoustic survey (#1) on August 26, 2011, using sample TS from fishery samples on August 24.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
G_outbox_2011_08_26	-34.01	224	-52.760	0.0134	2991	3009	101
G_inbox_2011_08_26_north	-34.99	323	-46.456	0.0714	23048	11552	50
G_inbox_2011_08_26_south	-34.1	323	-48.377	0.0373	12060	4299	36
G_total_2011_08_26	-34.37	870	-48.195	0.0438	38099	12688	33
Total In box	-34.55	646	-47.311	0.0543	35108	12326	35
After juvenile adjustment	-	-	-	-	30404	-	-

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
G_outbox_2011_08_26	N411800H	37.284	-34.01	-72.854	0.0001
	T411801H	36.122	-34.01	-49.702	0.0270
G_inbox_2011_08_26_north	K411802H	18.576	-35.18	-49.882	0.0339
	K411804H	18.415	-35.18	-55.870	0.0085
	L411802H	18.830	-34.91	-39.939	0.3144
	L411804H	18.309	-34.91	-48.807	0.0408
	N411804H	18.517	-35.02	-71.220	0.0002
	P411802H	18.463	-35.18	-47.404	0.0599
	P411804H	17.527	-35.18	-49.306	0.0387
	T411802H	18.569	-35.02	-46.700	0.0679
G_inbox_2011_08_26_south	K411803H	18.525	-34.17	-43.356	0.1207
	K411805H	18.614	-34.17	-47.865	0.0427
	L411803H	18.595	-33.91	-49.145	0.0299
	L411805H	18.555	-33.91	-50.831	0.0203
	N411805H	18.601	-34.01	-61.012	0.0020
	P411803H	18.738	-34.17	-50.006	0.0261
	P411805H	18.826	-34.17	-56.594	0.0057
	T411803H	18.267	-34.01	-46.837	0.0522

Table A7. German Bank acoustic survey (#2) on September 8, 2011, using sample TS from fishery samples on September 7-8.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
G_inbox_2011_09_08	-35.09	646	-42.737	0.1721	111164	51699	47
G_outbox_2011_09_08	-35.17	204	-50.984	0.0262	5344	2828	53
G_total_2011_09_08	-35.13	850	-43.728	0.1371	116508	51776.29	44

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
G_inbox_2011_09_08	A411801H	37.200	-35.17	-47.999	0.0521
	I411800H	37.256	-35.17	-42.122	0.2015
	K411800H	37.197	-35.32	-57.303	0.0063
	K411801H	37.177	-35.32	-57.115	0.0066
	L411800H	37.028	-35.06	-34.981	1.0179
	L411801H	36.395	-35.06	-44.792	0.1063
	M421800H	36.316	-35.06	-54.755	0.0107
	M421801H	37.036	-35.06	-38.814	0.4211
	N411800H	37.105	-35.17	-51.498	0.0233
	P411800H	37.296	-35.32	-54.060	0.0134
	P411801H	37.325	-35.32	-50.669	0.0292
	T411800H	36.443	-35.17	-39.908	0.3356
	T411801H	35.407	-35.17	-55.863	0.0085
G_outbox_2011_09_08	A411800H	37.295	-35.17	-47.991	0.0522
	I411801H	36.943	-35.17	-51.876	0.0213
	N411801H	37.027	-35.17	-58.280	0.0049

Table A8. German Bank acoustic survey (#3) on September 21, 2011, using sample TS from fishery samples on September 21.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
G_inbox_2011_09_21	-35.01	646	-41.575	0.2206	142509	84329	59
G_outbox_2011_09_21	-35.16	130	-54.750	0.0110	1428	693	49
Sealisland_2011_09_21	-35.07	136	-54.726	0.0108	1472	212	14
Total	-35.09	776	-42.329	0.1855	143937	84332	59

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
G_inbox_2011_09_21	I411800H	37.072	-35.07	-53.012	0.0161
	K411800H	37.358	-35.23	-52.171	0.0202
	L411800H	37.194	-34.96	-51.590	0.0217
	L411801H	37.130	-34.96	-61.665	0.0021
	M421800H	2.888	-34.96	-52.118	0.0192
	M421801H	37.166	-34.96	-33.005	1.5694
	N411800H	37.161	-35.07	-52.259	0.0191
	P411800H	37.155	-35.23	-57.556	0.0059
	P411801H	37.419	-35.23	-60.055	0.0033
	S411800H	36.085	-35.07	-54.103	0.0125
	S411801H	34.713	-35.07	-54.875	0.0105
	S511800H	37.265	-35.07	-47.253	0.0605
	T411800H	36.874	-35.07	-34.624	1.1082
	T411801H	36.580	-35.07	-52.028	0.0201
G_outbox_2011_09_21	N411801H	37.009	-35.07	-59.226	0.0038
	I411801H	37.262	-35.07	-63.925	0.0013
	K411801H	37.183	-35.23	-51.310	0.0246
	S511801H	37.274	-35.07	-53.568	0.0141
Sealisland_2011_09_21	A411800H	18.718	-35.07	-56.433	0.0073
	A411801H	18.842	-35.07	-55.324	0.0094
	A411802H	15.278	-35.07	-55.802	0.0084
	A411803H	13.881	-35.07	-53.609	0.0140
	A411804H	13.885	-35.07	-52.655	0.0174
	A411805H	19.387	-35.07	-54.884	0.0104

Table A9. German Bank acoustic survey (#4) on October 10, 2011, using sample TS from fishery samples October 10-11.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
German_2011_10_10	-34.79	640	-53.470	0.0135	8669.6	4522	52
German_2011_10_10_outbox	-34.72	222	-55.414	0.0085	1892.1	1794	95
Total	-34.755	862	-53.893	0.0123	10542	4522	43
Adjusted for Juveniles	-	-	-	-	9611	-	-

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
German_2011_10_10	K411800H	37.139	-34.88	-56.786	0.0064
	K411801H	37.052	-34.88	-61.691	0.0021
	L411800H	37.245	-34.62	-59.562	0.0032
	L411801H	37.198	-34.62	-67.939	0.0005
	M421800H	37.181	-34.62	-55.837	0.0075
	N411800H	37.149	-34.72	-47.582	0.0518
	P411800H	37.179	-34.88	-47.944	0.0494
	P411801H	36.029	-34.88	-70.762	0.0003
	S511800H	37.045	-34.72	-70.063	0.0003
German_2011_10_10_outbox	N411801H	36.804	-34.72	-50.792	0.0247
	S511801H	37.029	-34.72	-69.831	0.0003
	M421801H	37.058	-34.62	-66.541	0.0006

Table A10. Trinity Ledge acoustic survey (#1) on August 7, 2011, using sample TS from multi-panel gillnet sample of August 8.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
In box only	-35.53	0.43	-31.942	2.2827	981.6	178	18

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
In box only	W411800H_20110807_215427	0.174	-35.53	-39.283	0.4211
	W411801H_20110807_215604	0.418	-35.53	-31.627	2.4548
	W411802H_20110807_215913	0.458	-35.53	-36.978	0.7159
	W411803H_20110807_220252	0.609	-35.53	-32.097	2.2029
	W411804H_20110807_220723	0.550	-35.53	-31.030	2.8164
	W411805H_20110807_221151	0.608	-35.53	-31.689	2.4201
	W411806H_20110807_221626	0.512	-35.53	-32.448	2.0321
	W411807H_20110807_222043	0.558	-35.53	-29.574	3.9385
	W411808H_20110807_222503	0.367	-35.53	-29.695	3.8297
	W411809H_20110807_222820	0.346	-35.53	-42.589	0.1967

Table A11. Trinity Ledge acoustic survey (#2) on August 31, 2011, using sample TS from multi-panel gillnet sample of September 2.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
East_school	-35.72	1.01	-31.103	2.8977	2926.6	624	21
West_school_less_bias	-35.72	0.13	-32.599	2.0532	266.9	96	36
Total	-35.81	1.14	-31.249	2.8014	3193.5	624	20

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
East_school	W411800H_20110831_205555	0.453	-35.72	-34.571	1.3038
	W411801H_20110831_210003	0.452	-35.72	-54.720	0.0126
	W411802H_20110831_210320	0.877	-35.72	-41.064	0.2924
	W411803H_20110831_211013	0.519	-35.72	-37.311	0.6937
	W411804H_20110831_211404	0.466	-35.72	-32.934	1.9008
	W411805H_20110831_211806	1.151	-35.72	-28.245	5.5944
	W411806H_20110831_212748	1.078	-35.72	-29.391	4.2969
	W411807H_20110831_213525	1.616	-35.72	-30.446	3.3705
	W411808H_20110831_214604	1.015	-35.72	-29.063	4.6348
	W411809H_20110831_215321	0.652	-35.72	-29.913	3.8105
	W411810H_20110831_215740	0.628	-35.72	-57.885	0.0061
West_school_less_bias	W411820H_20110831_203913	0.354	-35.72	-30.822	3.0909
	W411821H_20110831_204138	0.314	-35.72	-32.355	2.1718
	W411824H_20110831_205036	0.316	-35.72	-30.688	3.1880
	W411825H_20110831_205257	0.372	-35.72	-74.518	0.0001

Table A12. Trinity Ledge acoustic survey (#3) on September 12, 2011, using sample TS from multi-panel gillnet sample of September 12.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
North_school	-35.30	0.61	-33.567	1.4898	908.8	108	12
South_school	-35.30	0.88	-29.774	3.5678	3139.7	451	14

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
South_school	W411820H_20110912_220938	0.565	-35.30	-27.223	6.4201
	W411821H_20110912_221259	0.659	-35.30	-28.668	4.6025
	W411822H_20110912_221715	0.767	-35.30	-27.645	5.8252
	W411823H_20110912_222202	0.776	-35.30	-29.435	3.8576
	W411824H_20110912_222652	0.988	-35.30	-29.338	3.9447
	W411825H_20110912_223247	0.965	-35.30	-29.502	3.7981
	W411826H_20110912_223839	0.986	-35.30	-30.319	3.1471
	W411827H_20110912_224428	1.005	-35.30	-30.999	2.6910
	W411828H_20110912_225021	1.081	-35.30	-30.443	3.0585
	W411829H_20110912_225647	0.956	-35.30	-30.739	2.8568
	W411830H_20110912_230237	0.650	-35.30	-62.259	0.0020

Table A13. Little Hope acoustic survey (#2b) on September 17, 2011, using standard TS (no samples).

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
East_school	-35.96	0.8	-44.264	0.1477	118.2	58	49
West_school	-35.96	0.4	-48.046	0.0618	24.7	11	44

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
East_school	H411803H_20110918_000452	1.027	-35.96	-49.509	0.0442
	H411804H_20110918_001013	0.912	-35.96	-39.253	0.4684
	H411805H_20110918_001531	0.793	-35.96	-41.656	0.2694
	H411806H_20110918_002015	0.932	-35.96	-47.409	0.0716
	H411807H_20110918_002540	0.943	-35.96	-52.591	0.0217
	H411808H_20110918_003455	0.913	-35.96	-49.299	0.0463
West_school	H411800H_20110917_231856	0.230	-35.96	-73.338	0.0002
	H411801H_20110917_232229	0.657	-35.96	-46.252	0.0935
	H411802H_20110917_232722	0.756	-35.96	-48.706	0.0531

Table A14. Stratum/school summary results for Little Hope acoustic survey (#2b) on September 27, 2011, using sample TS from multi-panel gillnet sample of September 24.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa (m^2)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
School01_pass1	-35.69	0.31	-32.166	2.2537	698.7	209	30
School02_pass2	-35.69	0.72	-32.367	2.1519	1549.4	213	14
School03_pass1	-35.69	2.28	-50.719	0.0315	71.7	70	97
School04_pass2	-35.69	0.31	-33.367	1.7092	529.8	194	37
Total	-35.69	6.78	-38.891	0.4791	3250	425	13

Table A15. Stratum/school summary results for Little Hope acoustic survey (#3) on October 7, 2011, using standard TS (no samples).

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
Sch01	-35.96	0.96	-37.377	0.7215	692.6	151	22
Sch02	-35.96	1.33	-41.949	0.2518	334.9	86	26
Sch03	-35.96	1.07	-44.765	0.1316	140.8	25	18
Sch04	-35.96	0.37	-50.340	0.0365	13.5	4	31
Sch05	-35.96	0.35	-36.707	0.8418	294.6	79	27
Sch06	-35.96	2.11	-32.751	2.0930	4416.3	1451	33
Sch07	-35.96	0.32	-33.457	1.7792	569.4	212	37
Sch08	-35.96	0.73	-48.522	0.0554	40.5	12	30
Sch09	-35.96	3.76	-33.755	1.6610	6245.5	1844	30
Total	-35.96	11.00	-35.319	1.1589	12748	2364	19

Table A16. Stratum/school summary results for Little Hope acoustic survey (#4) on October 18, 2011, using standard TS (no samples).

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
S1	-35.96	0.81	-45.222	0.1185	96.0	29	31
S2	-35.96	0.73	-45.835	0.1029	75.1	23	31
S3	-35.96	3.60	-36.629	0.8570	3085.2	483	16
S4	-35.96	0.71	-42.540	0.2197	156.0	32	21
S5	-35.96	1.89	-33.697	1.6835	3181.8	882	28
S6	-35.96	1.88	-34.897	1.2771	2401.0	858	36
Total	-35.96	9.62	-36.251	0.9350	8995.1	1323	15

Table A17. Stratum/school summary results for Little Hope acoustic survey (#6) on October 28, 2011, using sample TS from multi-panel gillnet sample of October 28.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
S1	-36.05	0.81	-40.442	0.363823	294.7	169	57
S2	-36.05	1.95	-43.683	0.1725	336.4	40	12
S3	-36.05	3.44	-36.866	0.8289	2851.3	911	32
S4	-36.05	1.51	-42.776	0.2126	321.0	142	44
TOTAL	-36.05	7.71	-39.120	0.4933	3803.4	938	25

Table A18. Stratum/school summary results for Eastern Shore acoustic survey (#1) on September 22, 2011, using sample TS from multi-panel gillnet sample of September 23.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
Ne_school	-35.72	0.13	-37.234	0.7048	91.6	53	58
South_school	-35.72	0.19	-33.475	1.6750	318.2	128	40
West_school_moh	-35.72	1.37	-33.795	1.5559	2131.6	633	30
West_school_tbs	-35.72	1.37	-35.913	0.9555	1309.1	408	31
Total (without West_sch_tbs)	-35.72	1.69	-33.943	1.5038	2541.4	647.983	25

Table A19. Stratum/school summary results for Eastern Shore acoustic survey (#2) on October 3, 2011, using sample TS from multi-panel gillnet sample of October 4.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
East_school	-35.93	1.22	-48.522	0.05505	67	40	60
West_school	-35.93	0.21	-42.654	0.21263	45	22	49
Total	35.93	1.43	-46.998	0.0782	112	46	41

Table A20. Stratum/school summary results for Eastern Shore acoustic survey (#3) on October 8, 2011, using sample TS from multi-panel gillnet sample of October 9.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
Tbs01	-36.15	4.73	-42.659	0.22355	1057.4	117	11
Moh01	-36.15	0.25	-31.160	3.15735	789.3	292	37
Moh02	-36.15	0.16	-28.202	6.23838	998.1	384	38
Total	-36.15	5.14	-38.722	0.55350	2844.8	496	17

Table A21. Stratum/school summary results for Glace Bay acoustic survey (#1) on September 15, 2011, using standard TS (no samples).

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
Glacebay_2011_09_15	-35.96	38.71	-64.729	0.0013	51.4	46	89

Table A22. Scots Bay acoustic survey (#1) on June 30, 2012, using sample TS from fishery samples on July 2.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
In_box	-35.50	626	-47.472	0.063495	39748	4170	10
Western	-35.50	43	-50.871	0.029037	1249	324	26
North	-35.38	109	-44.646	0.118454	12912	4147	32
East	-35.65	62	-45.873	0.094944	5887	8538	145
Total	-35.51	840	-46.964	0.071200	59795	10373	17
Out_box_only	-35.51	214	-46.964	0.093700	20047	9497	47

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
In_box	B412804H	40.614	-35.65	-49.969	0.0370
	B412806H	13.820	-35.65	-46.402	0.0841
	I412804H	44.799	-35.49	-45.464	0.1006
	I412806H	39.708	-35.49	-45.602	0.0974
	K412803H	44.067	-35.65	-48.290	0.0544
	K412805H	37.873	-35.65	-48.334	0.0539
	L412803H	41.908	-35.38	-48.066	0.0539
	L412805H	35.700	-35.38	-47.998	0.0548
	M422803H	42.697	-35.38	-48.257	0.0516
	M422805H	36.317	-35.38	-44.381	0.1259
	N412803H	43.879	-35.38	-47.129	0.0669
	N412805H	37.087	-35.49	-47.917	0.0572
	P412803H	43.881	-35.65	-45.791	0.0968
	P412805H	38.773	-35.65	-50.555	0.0323
	S412803H	41.492	-35.49	-52.303	0.0208
	S412805H	35.249	-35.49	-51.583	0.0246
	T412803H	41.117	-35.49	-46.988	0.0708
	T412805H	34.133	-35.49	-47.117	0.0687
Western	B412803H	2.674	-35.65	-50.595	0.0320
	B412805H	3.909	-35.65	-47.291	0.0685
	I412803H	2.226	-35.49	-64.502	0.0013
	I412805H	2.330	-35.49	-47.335	0.0654
	K412802H	2.400	-35.65	-1023.802	0.0000
	K412804H	3.364	-35.65	-56.489	0.0082
	L412802H	2.781	-35.38	-52.572	0.0191
	L412804H	2.618	-35.38	-49.043	0.0430
	M422802H	3.077	-35.38	-53.212	0.0165
	M422804H	3.348	-35.38	-48.072	0.0538
	N412802H	2.629	-35.38	-61.259	0.0026
	N412804H	2.852	-35.38	-55.095	0.0107
	P412802H	2.295	-35.65	-59.422	0.0042
	P412804H	2.205	-35.65	-55.712	0.0099
	S412802H	2.185	-35.49	-62.757	0.0019
	S412804H	3.072	-35.49	-51.183	0.0270
	T412802H	1.896	-35.49	-54.428	0.0128
	T412804H	2.357	-35.49	-44.668	0.1208
North	M412800H	35.255	-35.38	-41.983	0.2187
	M412801H	34.146	-35.38	-45.457	0.0983
	M412802H	33.064	-35.38	-46.265	0.0816
	M412803H	21.330	-35.38	-49.136	0.0421
East	C212800H	9.956	-35.65	-69.114	0.0005
	C212801H	10.576	-35.65	-57.705	0.0062
	C212802H	12.528	-35.65	-53.733	0.0155
	C212803H	6.933	-35.65	-50.933	0.0296
	C212804H	4.651	-35.65	-36.421	0.8370
	C212805H	1.375	-35.65	-59.423	0.0042

Table A23. Scots Bay acoustic survey (#2) on July 14, 2012, using sample TS from fishery samples on July 16.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
In_box_only	-35.34	626	-47.131	0.0662	41448	9076	22
Westend	-35.35	49	-50.003	0.0342	1678	343	20
East_of_box_approx	-35.31	81	-43.903	0.1383	11201	3430	31
North_of_box_approx	-35.50	62	-51.780	0.0236	1461	149	10
Total	-35.38	818	-47.001	0.0682	55788	9710	17
Out_box_only	-35.39	192	-46.602	0.0747	14339	3450	24

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
In_box_only	C212800H	43.037	-35.50	-50.868	0.0291
	C212801H	37.092	-35.50	-43.612	0.1545
	I412800H	48.829	-35.34	-56.788	0.0072
	I412801H	41.776	-35.34	-44.525	0.1207
	K412800H	48.854	-35.50	-61.112	0.0027
	K412801H	41.256	-35.50	-50.469	0.0319
	L412800H	45.390	-35.24	-48.790	0.0441
	L412801H	38.588	-35.24	-42.634	0.1821
	M422800H	45.903	-35.24	-47.751	0.0560
	M422801H	38.990	-35.24	-45.490	0.0943
	N412800H	48.736	-35.34	-43.017	0.1709
	N412801H	40.094	-35.34	-46.733	0.0726
	P412800H	48.876	-35.50	-60.722	0.0030
	P412801H	41.480	-35.50	-50.174	0.0341
	S412800H	44.312	-35.34	-49.245	0.0407
	S412801H	37.292	-35.34	-53.354	0.0158
	T412800H	43.759	-35.34	-46.039	0.0852
	T412801H	36.565	-35.34	-49.438	0.0390
Out_box	C212802H	5.547	-35.50	-40.241	0.3357
	M412800H	10.323	-35.24	-67.384	0.0006
	M412801H	12.120	-35.24	-64.493	0.0012
	M412802H	13.054	-35.24	-39.783	0.3510
	M412803H	3.922	-35.24	-64.872	0.0011
	M412804H	1.546	-35.24	-56.652	0.0072
	M412805H	3.216	-35.24	-46.809	0.0696
	M422802H	1.740	-35.24	-43.334	0.1550
	S412802H	4.928	-35.34	-43.485	0.1534
	T412802H	3.418	-35.34	-43.343	0.1585
	B412801H	11.368	-35.50	-52.802	0.0186
	B412802H	12.231	-35.50	-51.688	0.0241
	B412803H	15.591	-35.50	-51.225	0.0268

Table A24. Scots Bay acoustic survey (#3) on July 28, 2012, using sample TS from fishery samples on July 29-30.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
In_box_only	-35.42	626	-48.251	0.0521	32636	21050	64
Western	-35.41	40	-57.608	0.0060	241	122	51
North	-35.61	77	-46.780	0.0764	5880	1426	24
Total	-35.48	743	-48.277	0.0522	38756	21099	54
Outbox	-35.51	117	-48.414	0.0523	6120	1431	23

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
In_box_only	C212803H	40.123	-35.61	-55.540	0.0102
	C212805H	36.908	-35.61	-60.739	0.0031
	I412803H	43.867	-35.45	-58.020	0.0055
	I412805H	39.752	-35.45	-56.269	0.0083
	K412803H	39.429	-35.61	-72.629	0.0002
	K412805H	38.065	-35.61	-59.199	0.0044
	L412803H	35.920	-35.34	-50.799	0.0285
	L412805H	35.339	-35.34	-49.513	0.0383
	M412804H	40.741	-35.34	-49.791	0.0359
	M412806H	18.730	-35.34	-46.654	0.0740
	M412802H	13.992	-35.34	-50.092	0.0335
	M422803H_SONARNOISEREMOVED	37.185	-35.34	-46.597	0.0749
	M422805H_SONARNOISEREMOVED	36.384	-35.34	-50.977	0.0273
	N412803H	33.405	-35.45	-37.530	0.6194
	P412803H	42.397	-35.61	-62.032	0.0023
	P412801H	21.151	-35.61	-61.664	0.0025
	S412804H_NAV_REPLACED	38.862	-35.45	-54.319	0.0130
	S412801H_NAV_REPLACED	29.999	-35.45	-54.718	0.0118
Western	C212802H	2.819	-35.61	-58.422	0.0052
	C212804H	3.150	-35.61	-63.912	0.0015
	I412802H	2.704	-35.45	-69.671	0.0004
	I412804H	2.236	-35.45	-55.520	0.0098
	K412802H	3.057	-35.61	-1024.853	0.0000
	K412804H	2.541	-35.61	-55.247	0.0109
	L412802H	2.598	-35.34	-65.967	0.0009
	L412804H	3.077	-35.34	-53.015	0.0171
	M412803H	3.766	-35.34	-55.332	0.0100
	M412805H	1.205	-35.34	-48.754	0.0456
	M422802H_SONARNOISEREMOVED	2.635	-35.34	-63.524	0.0015
	M422804H_SONARNOISEREMOVED	3.042	-35.34	-58.908	0.0044
	N412802H	2.755	-35.45	-70.152	0.0003
	P412802H	1.814	-35.61	-69.789	0.0004
	S412803H_NAV_REPLACED	2.089	-35.45	-67.679	0.0006
North	B412800H	19.274	-35.61	-45.134	0.1115
	B412801H	16.395	-35.61	-45.247	0.1087
	B412802H	16.485	-35.61	-45.808	0.0955
	B412803H	16.797	-35.61	-50.078	0.0357
	B412804H	16.598	-35.61	-51.506	0.0257

Table A25. Scots Bay acoustic survey (#4) on August 11, 2012, using sample TS from fishery samples on August 13.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
In_box_only	-35.34	626	-50.216	0.0325	20369	7511	37
Western	-35.27	46	-60.520	0.0030	137	45	32
North_of_box	-35.13	31	-53.681	0.0140	433	0	0
Total overall	-35.25	703	-50.595	0.0298	20940	7511	36
Out box	-35.20	77	-56.469	0.0074	570	45	8

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
In_box_only	A412803H	32.286	-35.24	-51.082	0.0261
	A412805H	36.203	-35.24	-60.752	0.0028
	B412803H	42.612	-35.40	-47.145	0.0669
	B412805H	38.203	-35.40	-61.435	0.0025
	C212804H	20.437	-35.40	-44.203	0.1317
	C212801H	23.368	-35.40	-53.926	0.0140
	C212806H	36.700	-35.40	-60.478	0.0031
	I412804H	39.667	-35.24	-63.198	0.0016
	I412806H	15.138	-35.24	-60.630	0.0029
	I412802H	12.723	-35.24	-70.668	0.0003
	K412803H	40.006	-35.40	-43.250	0.1640
	K412805H	37.786	-35.40	-66.482	0.0008
	L412803H	37.073	-35.13	-54.007	0.0130
	L412805H	34.199	-35.13	-59.619	0.0036
	M412803H	39.152	-35.13	-51.750	0.0218
	S412803H	41.622	-35.24	-46.572	0.0736
	S412805H	35.117	-35.24	-63.151	0.0016
Western	A412802H	3.495	-35.24	-60.121	0.0033
	A412804H	2.960	-35.24	-54.784	0.0111
	B412802H	3.890	-35.40	-63.008	0.0017
	B412804H	1.341	-35.40	-62.580	0.0019
	C212803H	2.846	-35.40	-1024.543	0.0000
	C212805H	2.504	-35.40	-54.553	0.0121
	I412803H	3.886	-35.24	-63.297	0.0016
	I412805H	2.519	-35.24	-64.277	0.0012
	K412802H	2.583	-35.40	-73.108	0.0002
	K412804H	2.721	-35.40	-77.092	0.0001
	L412802H	2.388	-35.13	-61.790	0.0022
	L412804H	3.199	-35.13	-60.418	0.0030
	M412802H	3.129	-35.13	-58.786	0.0043
	S412802H	2.655	-35.24	-73.024	0.0002
	S412804H	1.455	-35.24	-64.796	0.0011
North_of_box	M412801H	36.050	-35.13	-53.681	0.0140

Table A26. Scots Bay acoustic survey (#5) on August 25, 2012, using sample TS from fishery samples on August 26-27.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
In_box_only	-35.21	626	-53.468	0.0149	9348	2589	28
Western	-35.18	44	-58.558	0.0046	202	52	26
Total	-35.20	670	-53.669	0.0143	9550	2590	27

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
In_box_only	A412803H	34.842	-35.22	-59.856	0.0034
	A412805H	39.086	-35.22	-54.926	0.0107
	B412804H	39.276	-35.38	-60.108	0.0034
	B412801H	12.325	-35.38	-65.153	0.0011
	B412806H	14.153	-35.38	-63.237	0.0016
	C212803H	42.427	-35.38	-54.564	0.0121
	C212805H	35.214	-35.38	-66.816	0.0007
	M412803H	39.987	-35.11	-48.759	0.0432
	M412805H	34.124	-35.11	-60.807	0.0027
	M422803H	40.617	-35.11	-48.850	0.0423
	M422805H	36.299	-35.11	-61.337	0.0024
	N412803H	44.286	-35.22	-49.492	0.0374
	N412805H	37.248	-35.22	-58.546	0.0047
	P412803H	45.584	-35.38	-59.533	0.0038
	P412805H	38.781	-35.38	-50.825	0.0285
Western	A412802H	2.803	-35.22	-63.133	0.0016
	A412804H	2.608	-35.22	-63.000	0.0017
	B412803H	2.695	-35.38	-60.964	0.0028
	B412805H	1.993	-35.38	-61.627	0.0024
	C212802H	1.205	-35.38	-56.815	0.0072
	C212804H	3.166	-35.38	-63.298	0.0016
	M412802H	1.950	-35.11	-54.795	0.0108
	M412804H	2.942	-35.11	-56.235	0.0077
	M422802H	3.148	-35.11	-53.139	0.0158
	M422804H	3.099	-35.11	-57.935	0.0052
	N412802H	3.956	-35.22	-58.151	0.0051
	N412804H	2.766	-35.22	-67.978	0.0005
	P412802H	2.356	-35.38	-63.719	0.0015
	P412804H	2.653	-35.38	-66.243	0.0008

Table A27. German Bank acoustic survey (#1) on August 12, 2012, using sample TS from fishery samples on August 11-14.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
German_in_box	-35.21	646	-48.257	0.050	32025	7221	23
German_outbox	-35.18	181	-55.952	0.008	1516	340	22
Total_2012_08_12	-35.20	827	-49.127	0.041	33541	7229	22

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
German_in_box	A412800H	35.915	-35.19	-44.206	0.1254
	A412801H	37.062	-35.19	-49.621	0.0360
	M422800H	36.768	-35.08	-51.656	0.0220
	N412800H	37.121	-35.19	-48.025	0.0521
	N412801H	37.118	-35.19	-51.406	0.0239
	P412800H	37.162	-35.35	-46.585	0.0752
	S512800H	36.423	-35.19	-46.539	0.0733
	S512801H	36.338	-35.19	-53.008	0.0165
	T412800H	36.836	-35.19	-47.314	0.0613
	T412801H	36.887	-35.19	-54.512	0.0117
German_outbox	M422801H	36.832	-35.08	-54.975	0.0103
	P412801H	36.562	-35.35	-57.226	0.0065

Table A28. German Bank acoustic survey (#2) on August 26, 2012, using sample TS from fishery samples on August 27-28.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
G_in_box_2012_08_26	-35.07	646	-43.067	0.159	102488	23508	23
G_outbox_2012_08_26	-35.13	198	-50.686	0.028	5506	2835	51
Total_German_2012_08_26	-35.10	844	-44.004	0.128	107995	23678	22

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
G_in_box_2012_08_26	A412800H	37.011	-35.08	-43.594	0.1408
	I412800H	36.048	-35.08	-43.712	0.1370
	K412800H	37.233	-35.24	-42.626	0.1824
	L412800H	37.240	-34.97	-41.483	0.2233
	L412801H	36.815	-34.97	-43.129	0.1529
	S412800H	36.625	-35.08	-46.088	0.0793
	S412801H	35.949	-35.08	-47.857	0.0527
	S512800H	36.849	-35.08	-43.026	0.1604
	S512801H	36.819	-35.08	-51.335	0.0237
	T412800H	36.570	-35.08	-38.282	0.4783
	T412801H	36.624	-35.08	-44.587	0.1120
G_outbox_2012_08_26	A412801H	36.900	-35.08	-47.798	0.0535
	I412801H	37.269	-35.08	-59.103	0.0040
	K412801H	36.971	-35.24	-51.048	0.0262

Table A29. German Bank acoustic survey (#3) on September 9, 2012, using sample TS from fishery samples on September 7.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
G_inbox_2012_09_09	-35.16	646	-45.573	0.0909	58699	24501	42
G_outbox_2012_09_09	-35.19	134	-55.612	0.0091	1217	331	27
G-Total_2012_09_09	-35.18	780	-46.304	0.0768	59917	24503	41

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
G_inbox_2012_09_09	B412800H	36.702	-35.31	-44.406	0.1230
	B412801H	36.111	-35.31	-52.229	0.0203
	C212800H	37.081	-35.31	-47.276	0.0635
	C212801H	36.867	-35.31	-53.578	0.0149
	K412800H	37.029	-35.31	-49.822	0.0354
	K412801H	37.075	-35.31	-56.315	0.0079
	L412800H	37.000	-35.04	-45.976	0.0806
	L412801H	36.814	-35.04	-52.644	0.0174
	M412800H	37.089	-35.04	-46.894	0.0653
	M412801H	36.869	-35.04	-50.656	0.0274
	M422800H	37.080	-35.04	-48.425	0.0459
	M422801H	37.026	-35.04	-52.909	0.0163
	N412800H	37.130	-35.15	-48.255	0.0489
	P412800H	37.160	-35.31	-51.342	0.0249
	S412800H	35.895	-35.15	-58.487	0.0046
	S512800H	37.024	-35.15	-36.994	0.6535
	S512801H	37.202	-35.15	-49.137	0.0399
	T412800H	36.724	-35.15	-38.856	0.4257
	T412801H	36.421	-35.15	-56.033	0.0082
G_outbox_2012_09_09	I412801H	36.904	-35.15	-55.119	0.0101
	P412801H	37.175	-35.31	-54.977	0.0108
	N412801H	36.974	-35.15	-53.889	0.0134
	S412801H	36.130	-35.15	-62.242	0.0020

Table A30. German Bank acoustic survey (#4) on September 22, 2012, using sample TS from fishery samples on September 21.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
G_inbox_2012_09_22	-35.01	646	-45.412	0.091	58933	24968	42
G_outbox_2012_09_22	-35.15	66	-58.874	0.004	280	125	45
G_Total_2012_09_22	-35.08	712	-45.814	0.083	59213	24968	42

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
G_inbox_2012_09_22	I412800H	36.744	-35.04	-52.175	0.0193
	I412801H	37.030	-35.04	-52.057	0.0199
	K412800H	36.383	-35.20	-60.000	0.0033
	M422800H	36.711	-34.93	-40.197	0.2975
	M422801H	37.260	-34.93	-51.305	0.0231
	N412800H	37.029	-35.04	-42.407	0.1833
	N412801H	37.033	-35.04	-58.325	0.0047
	P412800H	36.972	-35.20	-59.678	0.0036
	P412801H	37.070	-35.20	-58.494	0.0047
	S412800H	36.196	-35.04	-42.848	0.1656
	S512800H	36.818	-35.04	-48.166	0.0487
	S512801H	34.391	-35.04	-53.083	0.0157
	T412800H	36.150	-35.04	-38.178	0.4854
	T412801H	36.568	-35.04	-56.654	0.0069
G_outbox_2012_09_22	K412801H	36.941	-35.20	-57.334	0.0061
	S412801H	36.099	-35.04	-61.356	0.0023

Table A31. German Bank acoustic survey (#5) on October 7, 2012, using sample TS from fishery samples on October 8-9.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
G_inbox_2012_10_07	-34.8	646	-49.921	0.03072	19848	8229	41
G_outbox_2012_10_07	-34.87	166	-54.952	0.0098	1627	917	56
G_Total_2012_10_07	-34.84	812	-50.577	0.0264	21475	8280	39

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
German_2012_10_07	A412800H	36.946	-34.85	-63.299	0.0014
	A412801H	36.994	-34.85	-43.009	0.1528
	I412800H	36.465	-34.85	-57.369	0.0056
	I412801H	35.780	-34.85	-64.706	0.0010
	K412800H	36.946	-35.01	-56.104	0.0078
	K412801H	37.012	-35.01	-59.566	0.0035
	L412800H	37.216	-34.74	-44.303	0.1107
	L412801H	36.591	-34.74	-43.655	0.1285
	M422800H	37.003	-34.74	-59.731	0.0032
	M422801H	36.958	-34.74	-50.341	0.0276
	N412800H	37.132	-34.85	-56.533	0.0068
	N412801H	36.979	-34.85	-50.774	0.0256
	P412800H	37.020	-35.01	-60.981	0.0025
	P412801H	37.093	-35.01	-63.829	0.0013
	S412800H	37.136	-34.85	-59.371	0.0035
	S412301H	36.020	-34.85	-65.355	0.0009
	S512800H	37.085	-34.85	-50.013	0.0305
	S512801H	37.196	-34.85	-55.394	0.0088
	T412800H_SOUNDERNOISE	36.955	-34.85	-57.915	0.0049
	T412801H_SOUNDERNOISE	36.773	-34.85	-59.989	0.0031

Table A32. German Bank acoustic survey (#6) on October 24, 2012, using sample TS from fishery samples on October 25.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
German_2012_10_24	-34.99	0.38	-22.790	16.587	6303	804	13

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
German_2012_10_24	M422802H	0.434	-34.99	-22.821	16.4710
	M422803H	0.341	-34.99	-22.036	19.7330
	M422804H	0.210	-34.99	-20.896	25.6591
	M422805H	0.095	-34.99	-22.000	19.8989
	M422806H	0.388	-34.99	-22.511	17.6885
	M422807H	0.496	-34.99	-24.621	10.8811
	M422808H	0.456	-34.99	-26.431	7.1728
	M422809H	0.510	-34.99	-23.240	14.9548
	M422811H	0.183	-34.99	-22.098	19.4552
	M422812H	0.270	-34.99	-20.146	30.4913

Table A33. Trinity Ledge acoustic survey (#1) on August 7, 2012, using standard TS (no samples).

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
In box	-35.96	25.80	-62.834	0.002053	53	67	126

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
Trinity_2012_08_07	W412800H	5.310	-35.96	-70.952	0.0003
	W412801H	5.924	-35.96	-82.596	0.0000
	W412802H	6.209	-35.96	-74.045	0.0002
	W412803H	6.193	-35.96	-87.079	0.0000
	W412804H	6.210	-35.96	-90.512	0.0000
	W412805H	1.706	-35.96	-79.173	0.0000
	W412806H	1.598	-35.96	-51.722	0.0265
	W412807H	2.617	-35.96	-54.468	0.0141
	W412808H	1.726	-35.96	-84.944	0.0000
	W412809H	4.169	-35.96	-62.790	0.0021
	W412810H	2.603	-35.96	-86.381	0.0000

Table A34. Trinity Ledge acoustic survey (#2) on August 23, 2012, using standard TS (no samples).

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
South_school	-35.96	0.36	-36.788	0.826	297.4	121	41
Middle_school	-35.96	0.45	-37.016	0.784	352.8	156	44
North_school	-35.96	0.56	-39.566	0.436	244.1	140	57
In box total	-35.96	1.37	-37.811	0.653	894.0	242	27

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
South_school	W412800H	0.457	-35.96	-34.981	1.2526
	W412801H	0.532	-35.96	-61.802	0.0026
	W412802H	0.652	-35.96	-34.296	1.4665
	W412803H	0.629	-35.96	-38.557	0.5498
Middle_school	W412804H	0.587	-35.96	-35.424	1.1312
	W412805H	0.612	-35.96	-39.235	0.4703
	W412806H	0.549	-35.96	-34.002	1.5694
	W412807H	0.567	-35.96	-63.578	0.0017
North_school	W412808H	0.863	-35.96	-35.703	1.0606
	W412809H	0.693	-35.96	-67.031	0.0008
	W412810H	0.689	-35.96	-39.535	0.4389
	W412811H	0.567	-35.96	-54.858	0.0129

Table A35. Trinity Ledge acoustic survey (#3) on September 3, 2012, using standard TS (no samples).

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
In box	-35.96	0.22	-26.813	8.215	1807	214	12

Stratum Layer 1	Transect Number	Transect Length (km)	TS (dB/kg)	Average Sa ($/m^2$)	Biomass Density (kg/m^2)
Trinity_2012_09_03	W412800H	0.486	-35.96	-26.208	9.4425
	W412801H	0.583	-35.96	-26.560	8.7082
	W412802H	0.595	-35.96	-26.232	9.3908
	W412803H	0.554	-35.96	-28.674	5.3519

Table A36. Stratum/school summary results for Little Hope acoustic survey (#1) on September 25, 2012, using sample TS from multi-panel gillnet sample of September 25. Note that this survey was analysed using ECHO View software and data for all cells of the following table were not generated.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
Sep_24_School 1-H	-35.58	1.132	-26.588	7.930	8997	4489	0.50
Sep_24_School 2	-35.58	1.031	-30.883	2.991	3083	2139	0.69
Total	-35.58	2.163	-	-	12080	-	-

Table A37. Stratum/school summary results for Little Hope acoustic survey (#2) on October 10, 2012, using sample TS from multi-panel gillnet sample of October 9.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
Oct_10_School 1	-35.585	3.6	-42.845	0.188	676	109	0.16

Table A38. Stratum/school summary results for Eastern Shore acoustic survey (#1) on October 3, 2012, using sample TS from multi-panel gillnet sample of October 10.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
Esfpa_2012_10_03	-35.87	1.05	-34.197	1.471	1544	330	21

Table A39. Stratum/school summary results for Eastern Shore acoustic survey (#2) on October 26, 2012, using sample TS from multi-panel gillnet sample of October 25.

Stratum Layer 1	Average TS (dB/kg)	Stratum Area (km^2)	Weighted Mean Sa ($/m^2$)	Biomass Density (kg/m^2)	Strata Biomass (tons)	SE (tons)	SE (%)
Esfpa_2012_10_26	-36.13	0.32	-27.907	6.637	2124	707	33